
RESEARCH ARTICLE

Three Lessons from Japan on Architectural Resilience

Ariel Genadt

This article defines architectural resilience as architecture's capacity to support a community in regaining equilibrium after a powerful force has disrupted its organization. It considers architecture's physical, aesthetic, and symbolic aspects as equally important for its agency in a community, and argues that the combination of these aspects differentiates architectural resilience from structural resilience. To demonstrate this, the article looks at Japan, where powerful natural forces and human-inflicted devastation have frequently given the population cause to rethink the idea of resilience in their habitat and settlement patterns. This article focuses on three periods in Japan's history when architectural resilience was a key factor in the (re)development of the population's habitat. In the pre-industrial Edo period, resilience was attained by balancing scales of design: ductility of some buildings compensated for rigidity in others. The second period is that of the 1960s, when the Metabolist architects sought to accommodate change in buildings and cities by distinguishing rigid elements from malleable ones. But a penchant for technological specificity precluded the resilient balance. Finally, the article examines the reconstruction efforts following the 2011 Tōhoku earthquake and tsunami, when government plans to toughen the territory through infrastructure and to relocate the population overlooked the living preferences of specific communities and their connection to the ocean. In this instance, architects played a key role as mediators between people and their environment. These three cases demonstrate how a combination of rigidity and flexibility can ensure architecture's contribution to the regeneration of communities.

Introduction

Mighty environmental forces and human-inflicted devastation have frequently given Japan's inhabitants cause to rethink and implement the concept of resilience in their built environment. The Japanese relationship with nature has historically hovered between two poles: resistance through the use of inventive technology, and flexibility or accommodation to recurring earthquakes, floods, typhoons, and fire. Since Japan's industrialization, which began with the advent of the Meiji Restoration in 1868, universal engineering has prevailed as a driving force for resilience policies. Consequently, in the 20th century, the architectural expression of resistance has often eclipsed the principles of flexibility in many Japanese buildings, which have grown heavier and sturdier in adhering to increasingly prescriptive earthquake and fire resistance codes. But resilience in architecture is not solely defined in terms of a structure's massing or physical strength. This article casts light on the values of and difficulties in the application of resilience as an interplay of rigid and flexible elements, as they combine in one building, or as they interface in a set of architectural artifacts of various scales, from the joints of a single building to the expanse of an entire city.

Three historical periods demonstrate this kind of architectural resilience in Japan's history. The first is the Edo period (1603–1868), which laid the foundations of the

modern nation state, and in which recurrent earthquakes, floods, and fires challenged the built environment. Architectural resilience was achieved by balancing pliability in some buildings with a combination of ductility and rigidity in others, making the urban agglomerations and the nation as a whole resilient and prosperous. This logic can be understood in light of the mechanical definition of resilience.

In the second period considered here, the external force that shook Japan was the destruction inflicted by World War II, followed by extreme densification of its cities. In the 1960s, Tange Kenzō and the Metabolist architects sought to design buildings and cities that would adapt to change and facilitate growth, inspired by a biological analogy for resilience.¹ Yet their penchant for rigid engineering-reliant schemes ultimately limited their contribution to the evolution of communities.

The third period of reconstruction examined is that which followed the 2011 Great East Japan Earthquake (*Higashi Nihon daishinsai* 東日本大震災), when architects sought to complement the government-imposed, engineering-based prescriptions for 'toughening' with design approaches that were sensitive to the living preferences of the community. Architects contributed to the reconstruction efforts by empowering inhabitants while giving them an active role in restoring their relationship with the environment.

In bringing these three distinct historical periods into discussion with one another, this article promotes a nuanced understanding of architectural resilience. This approach sheds light on the diverse forms of architectural

resilience in the Japanese context, including those that have been practiced in the absence of a clear definition.

Toward a Definition of Architectural Resilience

Although resilience has only gained popularity as a topic in the field of ecology since its introduction by Crawford Stanley Holling in 1973, the concept has been used in Europe and America since 1858 in the field of mechanics (Holling 1973; Alexander 2013). Within that field, 'resilience' was defined as the interplay between rigidity – the ability of a structure or system to resist stress – and ductility – the ability of that same system to absorb stress through its own deformation (Alexander 2013: 2710). But long before resilience was endowed with its Western scientific dimension, vernacular forms of the concept were practiced in building construction worldwide.

The ambiguity of the concept, as employed in architecture today, is likely due to the fact that architects often borrow its definitions from the fields of mechanics, biology, botany, and ecology. In these fields, it is defined as a measurable, objective property of a structure, an organism, or a system. But architecture, which exists at the intersection of these scientific fields and the humanities, can never be abstracted from its context. Therefore architectural resilience must consider a building's quantifiable aspects – structural stability, energy and material use, capital, and environmental parameters – jointly with cultural-symbolic and aesthetic qualities.

In the absence of an authoritative definition, this article defines architectural resilience as a building's capacity to support a community in regaining equilibrium following a notable change or disruption in its organization. A community is understood as a village, a city, or a nation. This article understands architectural resilience as belonging not just to a single building but to the construct of its greater environment. This definition considers that architecture's physical, aesthetic, and symbolic aspects

are equally important for its agency within a community. Therefore, architectural resilience is distinct from structural resilience, as it pertains not purely to a building's internal properties but hinges on its greater social impact.

This article then looks at the specific context of Japan's built environment to examine this general definition. The example of Japan provides a long history of extreme and changing conditions in a culture in which the concept of resilience has been used in a variety of ways. Several words for 'resilience' exist in the Japanese language: *hanekaeri* 跳返, *fukugen-ryoku* 復元力, *kaifuku-ryoku* 回復力 and *kyōjinka* 強靱化. These terms have been used in different periods with distinct connotations, which this article will unfold in relation to the cases discussed.

Frank Lloyd Wright's design for the Imperial Hotel in Tokyo, built between 1915 and 1923, nicely demonstrates the difference between architectural resilience and structural resilience. The building's apparent rigidity and the fire resistance of its concrete, brick, and stone mass was coupled with ductility in its expansion joints, cantilevers, and short-pile foundations. Taken together, these features allowed the hotel to yield to movement, and to be 'resilient to return to [its] original position when distortion ceases', as Wright put it, during the Great Kantō Earthquake (*Kantō daijishin* 関東大地震) of 1923 (Wright 1932: 214). One may say that the building demonstrated architectural resilience, according to this article's definition, when it afforded shelter to numerous survivors following the earthquake, before they could recover their homes (Figure 1).

The Mechanical Analogy: Combining Ductility and Rigidity in Preindustrial Japan

The Japanese language equivalent to the European mechanical definition of resilience is *hanekaeri*, which appears in the dictionary in 1874, in the sense closely related to the Latin root *resilire* – to spring back or to



Figure 1: On the left, Frank Lloyd Wright, Imperial Hotel, Tokyo, in the aftermath of the Great Kantō earthquake on September 1, 1923. On the right is the Kangyō Bank on fire. Photographer unknown, Wikimedia.org <https://commons.wikimedia.org/wiki/File:Imperial_Hotel_FFW_11.jpg>.

rebound (Shibata and Koyasu 1874; OED). The term *fukugen-ryoku* (lit.: 'the capacity to return to the origin') is more commonly used today for that kind of resilience.

The mechanical connotation of 'resilience', as a structure that is at once both rigid and ductile, is particularly instructive in the examination of Japanese architecture in the Edo period (1603–1868). In Edo Japan under the Tokugawa Shogunate (*Tokugawa Bakufu* 徳川幕府), the nation achieved economic prosperity and socio-political equilibrium even though the majority of its population inhabited some of the world's most climatically and geologically vulnerable areas (Sorensen 2002: 1). By examining the scale of individual buildings constructed in the Edo period, along with the national class systems, and in the context of the ecological conditions and economy in which they came to be, it is possible to delineate specific design factors that created resilient settlement patterns. The decisive factors that contributed to resilient architecture in Edo Japan included a combination of top-down policies and private sector initiatives.

The skyline of Edo Japan was dominated by major public edifices, which structurally were the most resilient building types ever erected: wooden pagodas (*mokutō* 木塔) and castle keeps (*tenshukaku* 天守閣). But the structural

principles integral to these magnificent constructions were in fact already centuries old. Those principles were first deployed in the 7th century, in alignment with Taoist and Buddhist principles that espoused the value of yielding, as opposed to resistance, to unmatched powers. The alignment of structural and symbolic aspects amounted to an architectural resilience supporting the community's capacity to continue its life around a lasting spiritually symbolic beacon after the recurrent upheavals it endured. The extant 7th-century pagoda of Horyuji is the quintessential example of such vernacular design principles. It is believed that its form was inspired by Hindu myths and draws an analogy between the tree growing on the relics of Buddha and the building that incarnates the tenets of the faith (Fujimori and Fujitsuka 2017: 156–160, 200). The pagoda's structure was resilient due to the combination of a central free-standing or suspended rigid *hinoki* log (*shinbashira* 心柱) that absorbed the lateral thrust of the structure's otherwise loosely piled, flexible components.

The structural principles of Edo's numerous castle keeps, which also combined rigidity and ductility, likewise belonged to a prior age, having been perfected in the Azuchi-Momoyama period (1568–1600). Edo-period castles, such as Himeji-jō (**Figure 2**), were composed of flexible

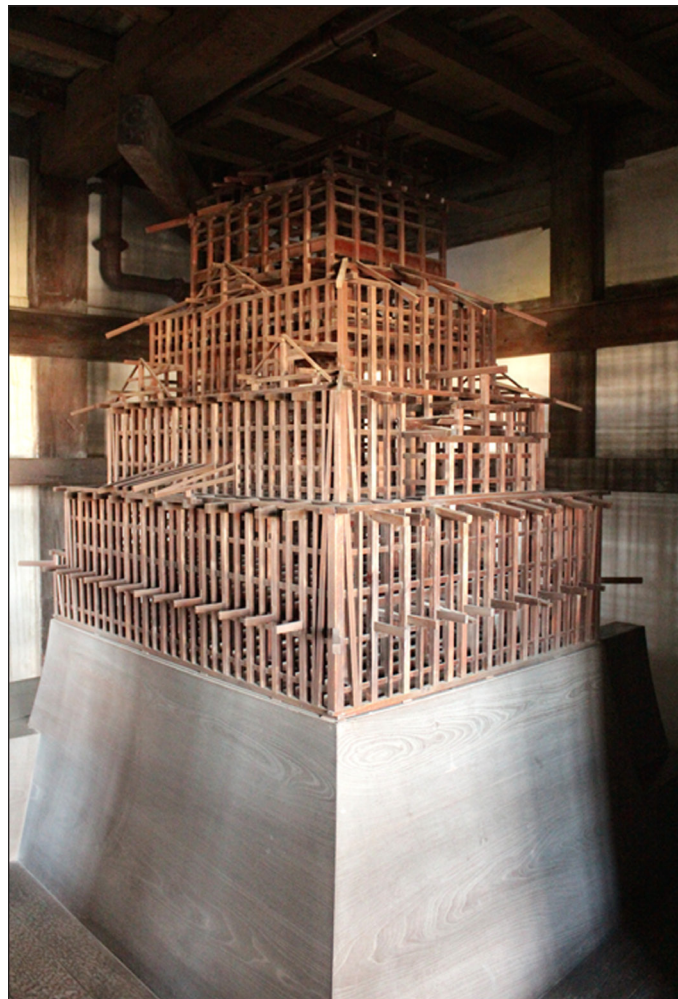


Figure 2: Model of the Himeji-jō keep's wood skeleton upon an earthwork foundation, exhibited inside the castle. Photo by Ariel Genadt, 2015.

trabeated timber skeletons, with four, full-height central pillars. On the exterior, the keeps' frames were entirely covered in fireproof clay daub and plaster. The keeps rested on a substructure of colossal earthwork with parabolic *ishigaki* 石垣— retaining walls made of imbricated cyclopean stones. These walls gave the keeps extraordinary rigidity in the face of tremors (Coaldrake 1996: 104–137).

The architectural resilience of these two types of public edifices was integral to the Tokugawa Shogunate's representation of both its political strength – that of its ruling and warrior classes – and the people's spiritual endurance. But these structures were not representative of the mainstream Japanese population. The homes constructed for Japan's lower classes in the Edo period, a population that comprised 90 percent of the entire country, were exceedingly ductile in their fabrication. Already before this period, the population was concentrated along the plains of the Pacific Belt (*Taiheiyō Beruto* 太平洋ベルト), which is explained by the geographic advantages of this region for the country's agrarian society. The ocean provided the people food and occupation, and the coastal plains were easier to cultivate and build upon than the mountains, which suffered cold winters and bore thin acidic soils (Sorensen 2002: 169). While some Edo *daimyo* (lords) built their mansions on the hills, the majority of the population remained in the low lands, where houses were vulnerable to recurrent earthquakes, tsunami, flooding rivers, and fires (Hein 2005). Built of renewable organic materials like timber, bamboo, bark, straw, and paper, the houses' elastic joinery and their floating foundations allowed them to sway and adjust in minor earthquakes (Seike 1977: 91). All the same, these structures were understood to be provisional, and were designed to give way to the stronger quakes and typhoons. The use of dry joinery enabled the

recovery of some building components, and facilitated repairs and rebuilding.

While the construction and restoration of Edo-period homes were in the purview of the private sector, their relative ductile construction was in fact sanctioned by the shogun's policies. Beyond the precincts of their castles, the Tokugawa shoguns chose not to fortify villages and cities against natural and human aggression. At the same time, they restricted the types of timber that could be used in the construction of commoners' homes, and did not enforce the use of fireproof construction materials for the majority of the population (Sorensen 2002: 42). Another Tokugawa policy was the 'alternate attendance' (*sankin-kōtai* 参勤交代), which obliged the *daimyo* and hundreds of their retainers to migrate between their country domains and the capital every year. The population movement that ensued spawned the unprecedented development of the capital Edo, the city of Osaka, and the 53 stations along the Eastern Sea Route (*Tōkaidō* 東海道) (Totman 1993: 108–111, 153–155) (Figure 3). The construction boom and its requirement of construction materials, which caused severe concerns about afforestation, was later met by the enforcement of state-controlled silviculture that significantly reduced the logging rate and ensured sustainable harvesting and the continuous supply of wood for new buildings as for reconstruction (Totman 1989) (Figure 4). Through these multiple measures, resilience was grounded in Edo's social and political context.

It has been suggested that the equilibrium in Japan's pre-industrial built realm relied on the disposition of its lower classes and their acceptance of the vulnerability of their wooden homes and shops. The people engaged in repeated reconstructions, using the same flammable materials, and they did so at their own expense. For



Figure 3: Utagawa Hiroshige, *Daybreak at Shinagawa*, No. 2 from the series *Fifty-three Stations of the Tokaido* (*Hoeido Tōkaidō*), ca. 1834. Ductile timber construction along the Pacific Coast in the Edo period. The Metropolitan Museum of Art <<https://www.metmuseum.org/art/collection/search/36923>>.

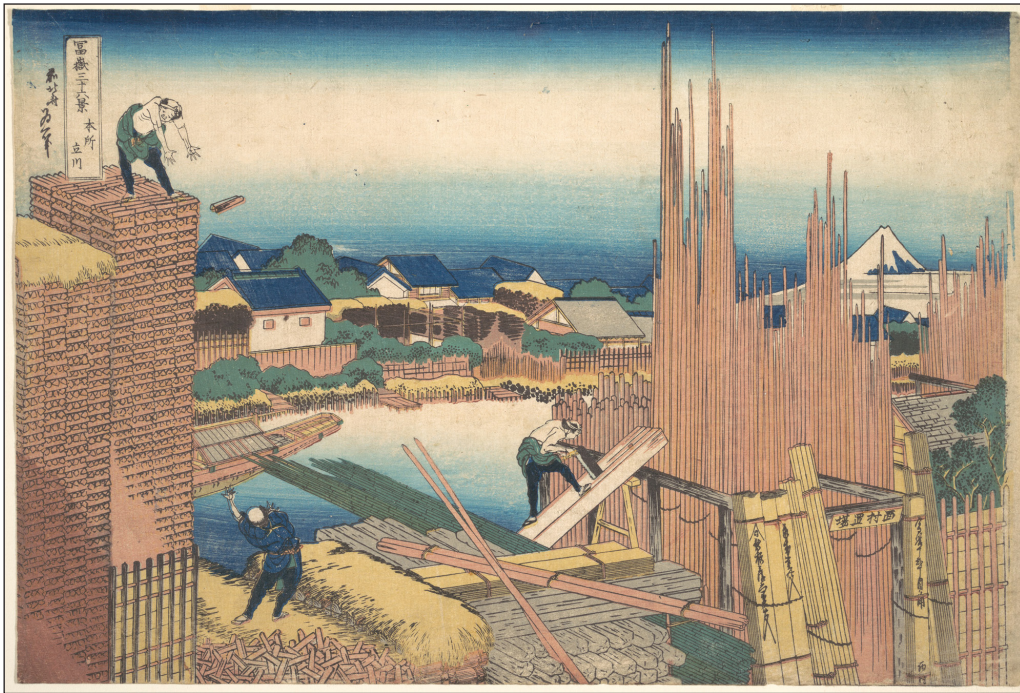


Figure 4: Katsushika Hokusai, *Horijō Tatekawa*. Carpenters in a lumberyard. From the series *Thirty-six Views of Mount Fuji* (*Fugaku sanjūrokkei*), ca. 1830–32. Stocks of lumber and bamboo ready at hand for quick reconstruction in the Edo period. The Metropolitan Museum of Art <<https://www.metmuseum.org/art/collection/search/56386>>.

artisans and merchants, this latter fact was likely driven by necessity and the need to mitigate business or professional losses (Hein 2005: 214–215). The willingness, and even proclivity, of the Japanese to rebuild has been espoused as a spiritual and even a racial virtue by Japanese scholars and philosophers since at least the Meiji era (1868–1912) and well into the 1940s, often with overtly nationalist motives. To cite just one example, in his efforts to promote pre-modern aesthetic values in 1905, Okakura Kakuzō wrote, ‘Though our sandals be changed, our journey continues; though our houses be burnt, our cities remain; and the earthquake but shows the virility of the mighty fish that upholds our island empire’ (Okakura 1905: 185). Notwithstanding the author’s nationalism, his poetic phrasing may be read as a summary of the components of resilience in preindustrial Japan. While the tools and technology of building continued to change, as did the buildings themselves, the human spirit that drove this industry persisted. The ductility of the individual house allowed the settlement as a whole to endure; great natural forces (evoked by the myth of the *Namazu* 鯰 catfish) may be unstoppable by humans, but they can nonetheless strengthen the human spirit if recognized as divine, or at least as a given. In short, Okakura’s words summarized the idea that in pre-industrial Japan, resilience was found through symbolic or spiritual continuity in the face of devastation. In fact, in the Edo period, little technological innovation in building construction was introduced after each event (Hein 2005: 213).

Yet Okakura’s romantic vision of the virtues of Japanese identity was not timeless. While the kind of resilience he praised may have flourished under the totalitarian regime in Edo, already by his own time, several decades into the Meiji reforms, much of the basis for equilibrium had been violated in the technological, material, and

cultural-symbolic aspects of architecture. By then, most of Japan’s castles had succumbed to peaceful demolition, as their military and symbolic functions were superseded, almost overnight, by modern technology and the desire to erase past symbols of authority. Moreover, knowledge of Western masonry and engineering inspired the Meiji government in its call for a ‘Strong Nation, Stone Nation’ (Clancey 2006: 11–38). State-enforced policies, driven by former samurai who became ministers and architects, replaced the pre-industrial idea of resilience as a balance between various scales of design with greater resistance of the individual building, integrating elasticity into an anti-seismic science. The equilibrium achieved in the Edo period between renewable timber construction and the coastal settlement pattern was thus disrupted. The new fireproof construction materials of brick, stone, concrete, and steel did not lend themselves, as timber did, to a sustainable regimen of recovery and reconstruction.

The main lesson from this preindustrial excursus is that architectural resilience may be achieved as a balance between ductility and rigidity at various scales of design, with the acceptance of some degree of destruction and a well-prepared framework for reconstruction. As we shall see, the emphasis placed on technology by later generations, and a decided lack of appreciation for its limits, hindered the prospect of architectural resilience in the 20th century.

The Biological Analogy and the Technological Limitations of Metabolism

A half-century after Okakura, the architect Tange Kenzō posited that material possibilities, political incentives, and mindset all played roles in affecting the extent to which the Japanese used technology to overcome clashes with nature. While he did not use the term resilience,

he addressed several principles related to the concept. He evoked the Jōmon (14,000–300 BC) and Yayoi (300 BC–300 AD) periods, in which people waged ‘spirited battles with nature’ using inventive technology. By contrast, in the subsequent period, people ‘had adopted ... an attitude of passive acceptance and compromise’ toward natural forces (Tange 1956: 26–27). Tange believed that this complacency had become part of a Japanese national identity, as manifest in the proliferation in art and literature of concepts such as *fūryū* 風流 – a philosophy of elegant refinement derived from the term’s literal meaning of ‘drifting along with the wind’ (1956: 27–30). Tange denounced this defeatist attitude, which he thought was latent in post-war Japan. Instead, he valorized the way Japan’s ancient people used technology to improve their habitat, as a model for modern architectural creation.²

Tange put his faith in technology into practice in the 1960s, when he designed a series of public institutional buildings. Composed of exposed reinforced concrete, the structures expressed rigidity and resistance in line with his understanding that in mid-20th-century Japan, ‘lightness,

openness or spaciousness, in the physical and psychological meaning, cannot satisfy people’s energies or desires. People want castles to live in. They want castles to work in’ (from a lecture in 1959, in Tange and Boyd 1962: 38) (Figure 5). Indeed, Tange’s public commissions may be regarded as architecturally resilient inasmuch as they provided the nation symbolic strongholds around which to reconstruct their national identity following the war, like the castles of Edo.

In the project ‘A Plan for Tokyo 1960 – Towards a Structural Reorganization’, the Tange Lab team combined technological innovation with a biological metaphor, proposing to extend the city onto Tokyo Bay, based on the growth pattern of a vertebrate organism (Tange 1961: 13) (Figure 6). The city’s new infrastructural ‘civic axis’ was compared to a spine, from which avenues stem in a linear structure. Tange considered the project an ‘open system’, contrasting it to Tokyo’s existing radial ‘closed system’, relying on a rather reductive formal definition of resilience: an organism’s capacity to support growth and accommodate change due to the composition and



Figure 5: Kurashiki Town Hall, 1960, Tange Kenzō, architect. A concrete ‘castle to work in’ that is architecturally resilient. Photo by Ariel Genadt, 2015.

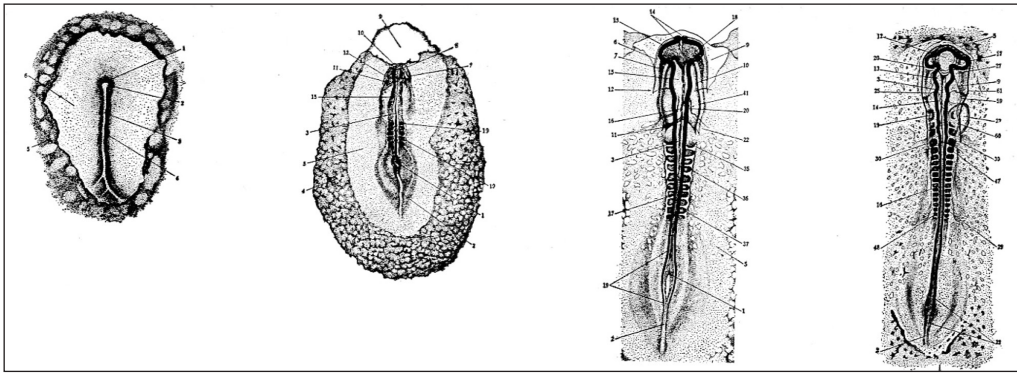


Figure 6: Tange Kenzō's biological analogy of a vertebrate organism's linear growth, reproduced in *A Plan for Tokyo*, 1960 (Tange 1961: 13).

organization of its parts. His future Tokyo was to be built using megastructural principles, raised on monumental concrete pilotis over land and water. Those would be serviced by an elevated transportation system and a futuristic telecommunication network, which Tange believed would respond to inhabitants' individualistic lifestyle (Yatsuka 2012: 53). The city's ability to accommodate growth and change was thus technology-dependent and imagined primarily as a problem of engineering. The architectural expression of its technology and modern building materials were thought to be suitable for reviving the nation's confidence, which is to say, contributing to the future city's architectural resilience.

More abstract biological analogies, along with Tange's techno-structural emphasis, appeared in projects by his disciples, notably those who self-identified as 'Metabolists'. The term suggested an attempt to embrace the inevitable changes that buildings and cities undergo throughout their lifetime, like living organisms. The architects' decision to publish their work as 'Metabolism', the English translation of the Japanese term *shinchintaisha* 新陳代謝, expressed their will to break from traditional, national, or regional forms, and imagine instead urban futures based on the universal language of the natural sciences. The figures involved in the group expressed the biological metaphor in different ways. Kikutake Kiyonori, for example, in his write-up of his Tower-Shaped Community project in 1959, described Tokyo as an organism that had become 'sick and fatigued' (Kikutake 2016b: 97). He proposed, in his description of his Marine City project, also of 1959, to remedy the problem by building 'metabolic' towers with parts that connect like 'bones and joints' (Kikutake 2016a: 94). Another of the group's members, Kurokawa Kishō, traced his ideas on Metabolism to his wartime experience in Nagoya, and described his Helix City (1961), shaped like a DNA molecule, using terms like 'growth', 'division', 'exchange', 'metamorphosis', and 'dynamic balance' — words he repeated in his later writings (Yatsuka 2011: 130).

The Metabolists' allusions to architectural resilience may be assessed on two scales: the individual building and the city. The latter scope of analysis is highly speculative, as none of the urban schemes designed by Tange, Kurokawa, and Kikutake were realized. At the scale of the individual building, most pertinent to architectural resilience was Kurokawa's idea that 'if spaces were composed

on the basis of the theory of the metabolic cycle, it would be possible to replace only those parts that had lost their usefulness and in this way to contribute to the conservation of resources by using buildings longer' (Kurokawa 1977: 32). In other words, the building would be endowed with *kaifuku-ryoku* — meaning resilience in the sense of a capacity to recover — like an organism recuperating from an injury or age-related deterioration of its organs.

That idea failed in practice, as quintessentially demonstrated in the Nakagin Capsule Tower (1972) (Figure 7). The problem lay in the fact that the 'changeability' of 'capsules', as Kurokawa called the dwelling units, was not solely determined by a so-called 'open' spatial form. The practical openness of the system hinged on industrial production where the original components would exist on the market throughout the building's lifetime, or could be affordably re-produced by a different manufacturer.³ Such conditions were rarely encountered in the second half of the 20th century, even though prefabricated dwellings had already been commercialized in Japan since the 1940s.⁴ Replacing 'capsules' in Kurokawa's designs turned out to be very costly due to the architecture's dependence on specific and rapidly evolving technology. Ironically, the reliance on the latest technological trends, which imbued Metabolist designs with their unique aesthetic appeal, was also the cause of their obsolescence. By the peak of the group's activity in the mid-1960s, a booming market economy turned buildings 'Made in Japan' into consumer products more conveniently disposed of than fixed. Kurokawa himself claimed to 'know of many instances in which entire buildings have been wastefully destroyed because portions of them were no longer serviceable' (1977: 32). His Nakagin Tower fell into disrepair for those same reasons he had identified in other buildings (Yamazaki 2010).

At the scale of the city, several speculative projects by Kurokawa and Kikutake were intended to create urban density in non-specified settlements along the Pacific Belt. Clustered in the air around colossal pilotis, the artificial ground planes they proposed to create in the air could prove fitting for Japan's uninhabited mountains, which for the industrial nation, no longer posed the same challenges as in Edo times. But instead, the architects sought to densify existing cities in the most environmentally vulnerable areas, including Tokyo Bay. Some projects were

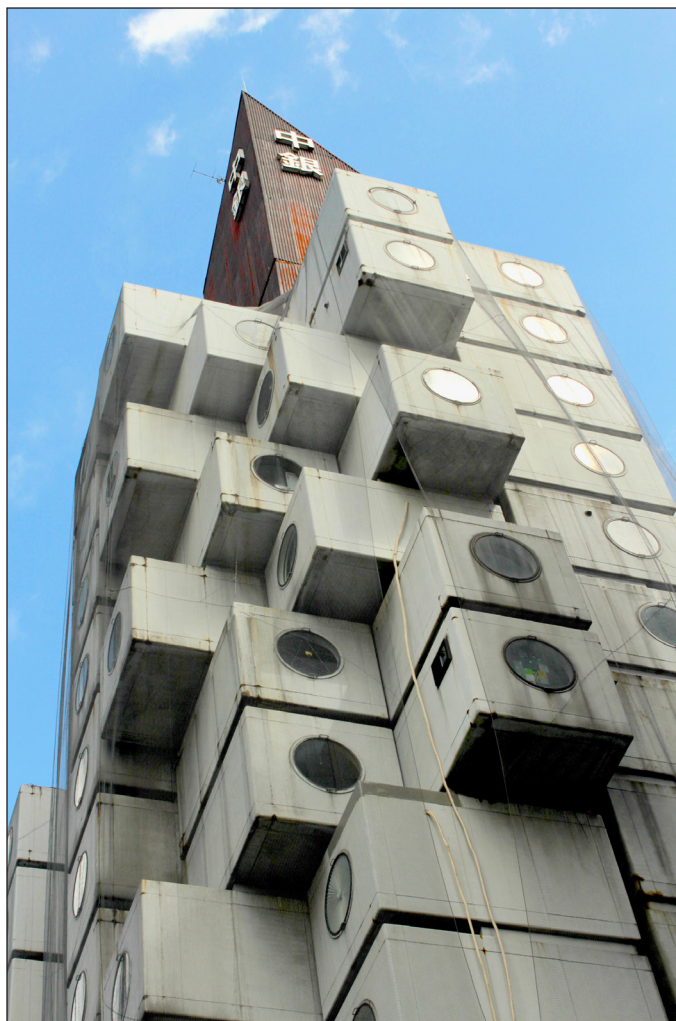


Figure 7: Nakagin Capsule Tower, Tokyo, in decay. Photo by Ariel Genadt, 2017.

to be inserted into the ocean, at the frontline of tectonic activity, such as Kikutake's Marine City projects of 1958 and 1963 and Ocean City Unabara of 1960. He imagined building these cities from concrete, steel, and plastic elements, all manufactured in situ, in a floating factory (Kikutake 2016a: 93).

Although the architects did not explicitly address it, their projects could have rekindled the idea of resilience as a balance between scales of design, based upon modern building technology and materials. The theoretical ease by which single prefabricated units could be replaced would have compensated for the vulnerability of the whole, and loose-fit steel components would have substituted pre-industrial timber joinery. However, none of the Metabolist proposals went into such detail.

Additional conflicts between Kurokawa's and Kikutake's urban schemes and the biological analogy for resilience can be gleaned from a recent reappraisal of architectural resilience by urbanist Michael Mehaffy and mathematician Nikos Salingaros. The two scholars proposed four characteristics of resilient cities based on lessons from biological systems. The first holds that resilient cities 'are not segregated into neat categories of use, type, or pathways', while the second provides that they 'feature diversity and redundancy of activities, types, objectives, and populations'. The third characteristic of resilient cities is that they 'have a wide distribution of scales of structure'. Finally,

according to Mehaffy and Salingaros, resilient cities 'can adapt and organize in response to changing needs on different spatial and temporal scales'. This is to say, they can 'self-organize' like a biological system, 'through the use of genetic information' (Mehaffy and Salingaros 2013).

These four points shed light on the limitations inherent in Kurokawa's and Kikutake's unrealized urban proposals. To begin, the distinction between superstructure and infill units in their megastructures would have prevented efficient connections to existing urban fabrics. In addition, although most projects featured elements of structural redundancy, the repetitive use of industrial housing units employed by Kurokawa and Kikutake would have afforded little room for diverse lifestyles. Further problems can be identified in the practical disconnect of the Metabolists' ideals. Although the group proclaimed to seek 'a continuous development from atom to nebula', in practice, the modulation of structure and capsules was antagonistic to the idea of biological variegation (Kawazoe et al. 1960: 4). Furthermore, despite numerous indications of all of the Metabolists' social intentions and novel thinking on future communities (Yatsuka 2011), most of the projects they devised dismissed the expression of the local identity and communal memory. Their focus on generic agglomeration overlooked the inherent 'genetic information' of place.

In sum, it may be said that the biological analogy used by Tange, Kurokawa, and Kikutake was too reductive. While

it had the potential to inspire greater organizational complexity on the urban scale and to hint at the idea of variegation at the scale of the individual building, the Metabolists' program was too limited for constructive implementation.⁵ Regardless of this problem, the group's ideas have been enormously influential in architectural practices worldwide, in large part due to their embrace of universal science and its expression in abstract spatial forms. For this reason, it is important to draw attention to the limits of the biological analogy in the conditions and manner the Metabolists used it, without dismissing the possibility that it might still inspire models of resilience under different technological circumstances. Meanwhile, the Metabolist idea that the environment can be unilaterally shaped by human invention has repeatedly proven to be dangerous, as the Great East Japan Earthquake of 2011 made clear.

Reconstructing Tōhoku: 'Toughening' and 'Genetic Information'

The reconstruction campaigns that followed the Great East Japan Earthquake and tsunami that struck the Tōhoku region on March 11, 2011, provide further instructive lessons on architectural resilience. The cataclysm killed 22,000 people and left 400,000 buildings in a state of partial or total ruin (Ubaura 2018: 56). Following the devastation, Prime Minister Abe Shinzō vowed to 'make Japan strong and flexible' and launched a National Resilience General Research Committee (Fujii et al. 2014: 17). The committee's plans were critically influenced by the expertise of civil engineer and public policy specialist Professor Fujii Satoshi, who was hired by Abe as an advisor to the Liberal Democratic cabinet in 2012.

The use of the term *kyōjinka* for resilience was popularized by Fujii in his 2011 book *Rettō kyōjinka ron* [The Archipelago Resilience Theory], in which he warns against doomsday scenarios of future earthquakes and proposed

measures to mitigate their damage. Since Fujii sees resilience as 'an issue of national defense', *kyōjinka* for him is bound with physical strength directed to combat natural forces (2014: 171). At the same time, Fujii's rhetoric uses the analogy of a willow tree to explain his view of 'national resilience' as a combination of toughness and flexibility. To achieve this, he recommends that a series of measures be taken in the construction realm to ensure the structural resilience of public buildings, especially of national institutions, and urges that robust and excessively sized infrastructure be built, a redundancy that would afford flexibility in times of turmoil (2014: 172). Other measures include colossal investments in the expansion of transportation systems, telecommunication networks, and energy production facilities, and in invigorating the Japanese economy in general. The titanic scale of this technology-dependent agenda brings to mind Tange's plan for Tokyo of 1960. Similar to Tange's idea of a linear open structure that would decongest the capital, Fujii advances the decentralization of Tokyo and spreading its future development along a linear system of cities, connected by *shinkansen* 新幹線 (bullet trains) and expressways. This would include existing cities along and beyond the Pacific Belt, and would revive urban centers that thrived during the Edo period (2014: 176–182).

The devastation of 2011 also spawned numerous private initiatives by architects, in contrast to Fujii's ideas for governmental action at the territorial scale. These architects were critical of reconstruction policies that focused on defensive civil engineering works and covering Japan's landscape with concrete, all of which were already widespread in the 20th century. Indeed, in 2011, the Tōhoku sea walls proved to be ineffective beyond a certain magnitude of tidal wave (Yeh, Sato, Tajima 2013: 1019–1031) (**Figure 8**). Instead, the architects' new residential and community-oriented designs rely on a balance between



Figure 8: The seawall (on the right) and the devastation in Taro, Iwate Prefecture, on April 6, 2011. Photo by Jim Peterson.

the unavoidable rigidity of defensive infrastructure at the urban scale and the ductility of the individual buildings. This approach seems to rediscover the tenets of preindustrial resilience as an equilibrium between ductility and rigidity through various architectural elements in tandem. The engineer Sato Jun, who was involved in several reconstruction projects, explained that this logic is supported by engineering considerations, whereby individual structures are calculated to withstand earthquakes and wind loads but are not designed to resist tsunamis. Taking tsunami loads into account would make them far too costly to build.⁶

Furthermore, the architects were wary of reconstruction plans that disregarded local cultural dimensions, such as government initiatives for ‘Group Relocation’, which consists in rebuilding destroyed villages on higher ground, away from the shoreline. While seemingly logical as a risk-reduction measure, this policy often conflicted with the inhabitants’ desires to maintain a connection with other members of the community, as well as with the devastated grounds of their familiar neighborhoods and with their way of life by the ocean – aspects which can be understood as the community’s ‘genetic information’ (Abe and Shaw 2014; Kitagawa 2016; Miyamoto 2016).

These aspects are embedded in the enigmatic Japanese term *fukkō* 復興, meaning ‘reconstruction’. According to Sendai Shōichirō, the word entered the architectural and urbanist discourses in 1923 following the Great Kanto Earthquake and has since been used in relation to disasters in particular (Sendai 2014: 133). Its etymological roots, *fuku* 復 and *kō* 興, make it inherently ambiguous, hinting at both the physical and spiritual aspects of a place. Traditionally, *fuku* signified ebb and flow, and is also part of *kaifukuryoku*, meaning resilience; *kō* means a ‘common foundation’ or ‘genius loci’. The combination of those signs designated something in decline, but which is regaining momentum. More than material reconstruction, *fukkō* originally indicated resignation in the face of lost landscapes, the memory of which reemerges in present projects. However, Sendai explains, its nuance seems to have been lost after World War II, likely because ‘in contemporary society, where objective data is controlled by the authorities, one no longer perceives the human in the milieu’ (2014: 135). The implications of this last remark may be witnessed in the reconstruction efforts of Tōhoku, where the government’s reliance on data sometimes undermined the input from the community it was trying to rebuild.

Meanwhile, a re-emergence of *fukkō* in its original place-bound sense can be noted in building projects by two of the many pro bono architect-driven initiatives for reconstruction, ArchiAid and Home-for-All. Their work between 2011 and 2016 reveals an approach to architecturally resilient reconstruction. The strength of a resilience based on ‘genetic information’ versus technology-based ‘toughening’ or *kyōjinka* was described by the founder of Home-for-All, Itō Toyō:

Top-down plans for recovery stress only ‘safety and security,’ ignoring the land’s memories and relying instead on modernist methods. Dismantling the relationships between people and the natural

world and the heart-to-heart interpersonal connection that constitute the region’s historical legacy, they prefer to push plans heavily dependent on civil engineering technology. But those strong-willed individuals hoping to return to their original land and act as inheritors of the past are people who aspire to a future linked to the past, using those leftover foundations as their foothold. (Itō 2013: 20)

Descriptions by architects involved with the ArchiAid group confirm Itō’s narrative. Many of them have negotiated conflicts between governmental and community priorities through a collaborative process based on meetings and workshops with the survivors. They have defined and prepared the groundwork for several communities to re-engage with their natural milieu, while reaffirming their ancestral relation to the ocean. Their work comprised both housing projects and community facilities. In almost all of the cases documented by ArchiAid and Home-for-All, the dread of recurring ravages did not lead to the adoption of expressively resistant construction. The houses and public buildings built under these initiatives used timber expressively, with occasional recourse to steel frames or connectors. The following two examples best demonstrate this kind of architectural resilience.

The most publicized among the Home-for-All projects is a two-story, 30-square-meter building in Rikuzentakata (Figures 9 and 10). Its construction stemmed from Itō’s skepticism regarding the patent reliance of the government on civil engineering, which he felt eclipses humans in their milieu. Itō’s feeling arose from witnessing some 50,000 prefabricated dwelling containers installed in several villages as quick relief to the homeless (Itō et al. 2014: 60–61). Five decades after working for Kikutake (from 1965 to 1969), Itō experienced a visceral aversion to the idea of repeating any Metabolist-like experiments. To mitigate the isolation of dwelling units – their disconnection from nature and lack of spaces for civic encounters – Itō initiated the construction of several community centers.

At Rikuzentakata, the inhabitants debated where to locate their new communal space. They eventually chose a site at the tip of a promontory overlooking the area that had been inundated. This represented a middle ground between the elevated site, where many would relocate following government initiatives, and the destroyed ocean-front that held vivid memories (Itō 2013).⁷ The architects of this project chose certain building materials, a structural system, a volumetric composition, and a particular topography to express the inhabitants’ desire to reconnect to their pre-disaster environment. For the building structure, they harvested 19 cedar logs from the nearby forest, which had remained standing after the tsunami but were soaked in salt water and bereft of foliage. The logs were repositioned on the new site like relics of a forest. That log structure supports open platforms and volumes that seem suspended like tree houses. They form an artificial ground spiraling upward from the hill to dominate the surroundings. Conceptually, the small community center bears similarities to Metabolist projects: a clear distinction of a superstructure and infill parts an expressively aggregative



Figure 9: Home-for-All Community Center, Rikuzentakata, 2012. Itō Toyō, Inui Komiko, Hirata Akihisa, and Fujimoto Sou, architects. Photo: Google Street view, image capture June 2013, © Google 2019 <<https://goo.gl/maps/i7a6hb-hdHUc8VDpT7>>.



Figure 10: Home-for-All Community Center, Rikuzentakata. Itō Toyō, Inui Komiko, Hirata Akihisa and Fujimoto Sou, architects. Trunks repositioned as structure. Photo by Jun Sato, 2013.

construction, a redundancy of structural members, and even an artificial ground. But it is drastically different in that the human scale was the measure of all design choices, from its irregular structure and infill elements to the use of local materials and labor rather than universal technology.

The second and most poetic example of architectural resilience in Tōhoku reconstruction is the small temple rebuilt in 2013 beside the coastal road near Ishinomaki City to shelter the homeless statues of the Buddhist divinity Ojizōsama 地藏, the protector of children and travelers, cherished by the Kozumihama village community (Iida 2016: 194–199) (Figures 11, 12, and 14).⁸ Under

the ArchiAid initiative, a group of Hosei University students of the Watanabe Makoto Shin and Shimohigoshi Taketo Studio designed and built an open shed, shaped as a leaning half-dome of cedar beams, stagger-stacked with an incremental planar rotation. The structure's rigidity is ensured by a concrete foundation and the lumber's weight, while its porosity reduces loads against oceanic gales. The tensile-resistant joint system, developed by engineer Sato Jun, uses cylindrical wooden split-wedges (*warikusabi* 割楔), concealed within the thickness of each beam (Figure 13). Thus, in the completed structure the lumber appears to be simply stacked like giant Mikado pick-up sticks. This traditional jointing strategy allowed



Figure 11: Kozumihama Ojizō-sama Project, Ishinomaki, 2013. View of the temple from the littoral road. Watanabe+Shimohigoshi Independent Studio. Photo by Hiroyuki Hirai.



Figure 12: Kozumihama Ojizō-sama Project, Ishinomaki, 2013. Construction by Hosei University students. Watanabe+Shimohigoshi Independent Studio. Photo by Hiroyuki Hirai.



Figure 13: Kozumihama Ojizō-sama Project, Ishinomaki, 2013. *Warikusabi* split wedge joint detail. Photo by Jun Sato.



Figure 14: Kozumihama Ojizō-sama Project, Ishinomaki, 2013. View of the temple from within. Watanabe+Shimohigoshi Independent Studio. Photo by Hiroyuki Hirai.

carpenters of old to design temples that looked much more delicate than they were. At Ishinomaki, the flagrant contrast between the site's exposure to nature's mighty forces and the shelter's lightness embodies the notion of *fūryū*: the structure stands but appears so fragile that it might drift with the wind in the next storm. Its sophisticated, resilient structure is concealed behind a frail outward demeanor that quietly expresses its symbolic-spiritual value. Like the Home-for-All community center at Rikuzentakata, the Ojizōsama temple is an exquisite example of architectural resilience in its capacity to support the Kozumihama community's recovery by responding to both its desire for a durable spiritual symbol and being in tune with nature.

Many more ArchiAid and Home-for-All projects could be discussed in relation to their resilience and response to the effects of the 2011 earthquake, but clearly, such initiatives remain a drop in the ocean when compared to the number of people still affected by the devastation. Nevertheless, as with the Metabolist projects, the media coverage of the architects' work is an important part of their contribution to reconstruction and architectural resilience that complement the government's efforts toward *kyōjinka*. In the Tōhoku case, the architects' collaborative engagement with the population and place-sensitive designs are alternatives to much of the construction being carried out in the region, even if this means overcoming the difficulties

encountered due to their reliance on untrained volunteers or students. These projects harnessed the moral value of community participation and solidarity expressed by people from other regions in Japan.

Conclusion: Architecture? Possible Here!

The three periods examined in this article demonstrate different ways in which Japan's master carpenters and architects, and the Japanese people more generally, have combined forms of resistance and flexibility in the face of devastation. Yet, considered together, the three periods reveal that there has not been a continuous, coherent method for achieving architectural resilience. In Japan, age-old knowledge of the principles of structural resilience does not readily yield buildings that fulfill the need for social resilience. Rather, this knowledge has had to be combined with political, social, technological, and cultural-symbolic considerations, resulting in an inconsistent and discontinuous practice of architectural resilience over time.

The mechanical connotation of resilience, the idea that buildings need to be able to 'spring back' from destruction, provides a particularly instructive model for examining the architecture of Edo Japan. The consideration of Edo's built environment teaches that architectural resilience was achieved as a balance between various architectural elements at different scales of design. Yet this type of balance was dependent on the propitious socio-political

structure and centralized power that existed in the feudal era. Although the Tokugawa regime may seem distant from modern democratic systems, and while the architectural resilience it fostered through its policies was not theorized as such, it still provides an architectural lesson for the 21st century. Building codes and standards are commonplace in most countries today, and the extent to which the state is capable of restricting the private sector's freedom in the construction realm cannot be directly linked to one type of regime. When in the Meiji era Japan was freed from totalitarian rule, anti-seismic building codes became far more restrictive than they ever were before (this is still the case today), albeit affecting all classes of society. But as we have seen in the subsequent periods, building codes did not ensure the architectural resilience that had existed in Edo Japan.

In the postwar years, the Metabolists too sought to combine the rigidity or permanence of some building elements with the flexibility of changeable ones, at the scale of both building and city alike. But perhaps it was the lack of entrepreneurial centralization and the instability of the industrial realm in a thriving market economy of the 1960s that thwarted the promise of 'openness' in megastuctural schemes. The lesson from this second period is that technology alone cannot ensure architectural resilience, even when that resilience is well conceived as an interplay of rigid and flexible elements. The reappraisal of the biological analogy by Mehaffy and Salingaros, as opposed to its reductive formal interpretation by the Metabolists, has shown the complex and ambivalent factors, both techno-scientific and cultural-symbolic, which come into play in architectural resilience.

Tange Kenzō's remark of 1956 regarding the historic inconsistency of the Japanese motivation to combat natural forces through the use of technology seems to persist in 21st-century Japan. The government that conceived of national resilience in terms of measures of risk reduction, structural stability, infrastructural strength, capital investment, and energy generation fell short in addressing the human attachment to place and lifestyle that is in tune with nature's cycles. This third period shows that although people in devastated areas may applaud their government's efforts to strengthen infrastructure, in their quotidian interaction with the environment many of them prefer to live within an architecture that expresses a less conflictual relationship with nature.

Upon witnessing the devastation in Rikuzentakata, Itō Toyō wondered what the role of an architect might be in such conditions. He asked, 'Architecture. Possible here?' (Itō 2013: 20–21). His answer was to facilitate the adoption of a balanced approach to resilience, which harnesses the 'genetic information' and genius loci toward an architectural conception that manifests its reciprocal interaction with nature. In their reliance on the resolve and psychological resilience of a community, projects like the Home-for-All community center and the Ojizōsama temple address the cultural-symbolic and aesthetic aspects of architectural resilience, while concealing the necessary structural measures that endow them with some stability. In contrast to the castles of Edo and the metaphoric 'castles to work in' conceived by Tange in the 1960s, the

two 21st-century projects teach a third lesson, that resilient architecture often *needs* to appear as if it is ready to drift away with the wind or to be swept away by the waves. This aesthetic aspect is necessary when architecture aims to frame a familiar yet altered relationship between people and their natural milieu. In Tōhoku, supporting the community in regaining equilibrium meant incorporating a constant reminder of the lost landscape and of nature's ebb and flow, with humans in its midst – in a word, *fukkō*.

Although the scope of this article is limited to the discussion of just three periods of Japan's history, these alone are enough to suggest the absence of any cultural, political, or technological determinism, as regards architectural resilience. This enables one to extrapolate certain lessons to other contexts. Further research might examine the architecture of the modern periods not addressed here, such as the Meiji era, the interwar years, the time of Japan's bubble economy, and the so-called 'Lost Decade' that followed. In each period and case study, a cross-disciplinary approach could address both structural and material aspects of building and cultural-symbolic aspects. This would support an understanding of the unique role that architectural resilience, as distinct from structural resilience, plays in building communities in climate-stricken zones. Ultimately, it would affirm architecture's agency toward sustaining communities in dealing constructively with both global engineering and climate change.

Notes

- ¹ Japanese person names in the text are given in the traditional form: surname–first name.
- ² The kind of resilient attitude extolled by Okakura as a national strength had gained traction among scholars and poets, who debated the attitude to adopt in the face of Western influence, culminating in 1942 in the two-day symposium 'Overcoming Modernity' (Calichman 2008). Tange, who in his essay 'A Eulogy to Michelangelo' of 1939 had cautioned against a simplistic adoption of machine aesthetics and the loss of poetry in architecture, enthusiastically embraced modern technology after the war, and inveighed against a romantic aestheticization of the relationship between Japanese culture, nature, and technology.
- ³ Jean Prouvé, an expert in factory-made housing in the postwar years, made a similar point on the unfeasibility of 'open systems' when he explained that 'machines are seldom assembled from components of various origins; they are built as units. I cannot agree in any way to this proposed formula of open system prefabrication' (Prouvé 1971: 24–25).
- ⁴ The PREMOS company, founded by Maekawa Kunio and Ono Kaoru in 1946, has been identified as the progenitor of prefabricated housing in Japan. In the five years of its existence, the company constructed over 1000 units, more than any other before it (Reynolds 2001: 145–149). See also Oshima (2008).
- ⁵ The shortcomings of Kurokawa's and Kikutake's reductive use of the biological analogy could already be gleaned from the alternative organizational principles proposed by their peers Maki Fumihiko and Otaka Masao in the project titled 'Group Form', published in

the Metabolism 1960 volume. The future city by Maki and Otaka was inspired by Italian and Greek hill towns that 'self-organized' based on 'genetic information'. They understood that vernacular patterns and their relation to the ground – as topography and as a symbol – were key to the towns' resilience, since the involvement of inhabitants reinforced their links to each other and to the place. Maki overtly critiqued his peers' proposals in 1964, noting the limitations of megastructures (a term he coined), such as their rigidity and excessive reliance on technology (Maki 2008: 44–56).

⁶ As explained by Eng. Sato Jun in an email to the author, March 23, 2018.

⁷ The architects' team included Itō Toyō, Inui Komiko, Hirata Akihisa, and Fujimoto Sou.

⁸ Explanatory text and images kindly provided to the author courtesy of Watanabe Makoto and Shimohigoshi Taketo.

Acknowledgements

I'd like to express my sincere appreciation to the diligent reviewers and editors of *Architectural Histories*, and to my colleagues Gideon Fink Shapiro and Lori Gibbs, for their scrupulous readings of drafts of this article, and for their helpful suggestions. I kindly thank Yatsuka Hajime for enlightening me on the semantic nuances of the Japanese terms for resilience. Many thanks to Sato Jun and Shimohigoshi Taketo for providing information about their projects in Ishinomaki. And finally, I'm grateful to Jim Peterson for sharing his shocking and moving photos of the devastation in Tohoku, which motivated me to reflect on a more resilient and hopeful future for the region.

Competing Interests

The author has no competing interests to declare.

References

- Abe, M** and **Shaw, R.** 2014. Community Resilience after Chuetsu Earthquake in 2004: Extinction or Relocation? In: Shaw, R (ed.), *Community Practices for Disaster Risk Reduction in Japan*. Tokyo: Springer. DOI: https://doi.org/10.1007/978-4-431-54246-9_11
- Alexander, DE.** 2013. Resilience and Disaster Risk Reduction: An Etymological Journey. *Natural Hazards Earth Systems Science*, 13: 2707–2716. DOI: <https://doi.org/10.5194/nhess-13-2707-2013>
- ArchiAid.** 2016. *Archi+Aid Record Book, 2011–2016. Architects' Pro Bono Outreach Following 3.11 [Ākieido. Ākieido gonēkan no kiroku: higashinihon daishinsai to kenchikuka no borantarī na fukkō katsudō.]* Sendai: Ākieido.
- Calichman, R.** 2008. *Overcoming Modernity: Cultural Identity in Wartime Japan*. New York: Columbia University Press.
- Clancey, GK.** 2006. *Earthquake Nation: The Cultural Politics of Japanese Seismicity: 1868–1930*. Berkeley, CA: Univ. of California Press. DOI: <https://doi.org/10.1525/california/9780520246072.001.0001>
- Coaldrake, WH.** 1996. *Architecture and Authority in Japan*. London: Routledge.
- Fujii, S.** 2011. 列島強靱化論: 日本復活5カ年計画/*Rettō kyōjinka ron: Nihon fukkatsu 5kanen keikaku [Theory of Resilience of the Archipelago – A Five-Year Plan for Japan's Resurrection]*. Bungeishunju, Bunshun shinsho. p. 809.
- Fujii, S,** et al. 2014. *Kyōjinka: Building National Resilience: Against Disasters in Japan, Asia, and the World*. Tokyo: The TOA Institution.
- Fujimori, T** and **Fujitsuka, M.** 2017. *Japan's Wooden Heritage: A Journey Through Thousand Years of Architecture*. Tokyo: Japan Publishing Industry Foundation for Culture.
- Hein, C.** 2005. Resilient Tokyo – Disaster and Transformation in the Japanese City. In: Vale, LJ and Campanella, TJ (eds.), *The Resilient City: How Modern Cities Recover from Disaster*. Oxford: Oxford University Press. pp. 213–234.
- Holling, CS.** 1973. Resilience and Stability of Ecological Systems'. In *Annual Review of Ecology and Systematics*, 4: 1–23. DOI: <https://doi.org/10.1146/annurev.es.04.110173.000245>
- Iida, H.** 2016. Kozumihama Ojizō-sama Project. In: *ArchiAid, Archi+Aid Record Book, 2011–2016. Architects' Pro Bono Outreach Following 3.11*. Sendai: Ākieido. pp. 194–199.
- Itō, T.** 2013. *Architecture. Possible Here? 'Home-for-All'*. Tokyo: Toto.
- Itō, T, Dartois-Ako, M** and **Quentin, C.** 2014. *L'architecture du jour d'après*. Bruxelles: Les impressions nouvelles. (First published as T. Itō, *Ano hi kara no kenchiku. あの日からの建築*. Tokyo: Shūeisha, 2012).
- Kawazoe, N,** et al. 1960. *Metabolism: The Proposals for New Urbanism*. Tokyo: Bitjutu Syuppan Sha.
- Kikutake, K.** 2016a. Marine City [1959]. In: Kikutake, K and Oshima, KT (eds.), *Between Land and Sea*. Zurich: Lars Muller Publishers. pp. 92–95.
- Kikutake, K.** 2016b. Tower-Shaped Community [1959]. In: Kikutake, K and Oshima, KT (eds.), *Between Land and Sea*. Zurich: Lars Muller Publishers. pp. 96–99.
- Kitagawa, K.** 2016. Land Planning in Fukkiura and Sudachiyashiki. In: *ArchiAid, Archi+Aid Record Book, 2011–2016. Architects' Pro Bono Outreach Following 3.11*. Sendai: Ākieido. p. 159.
- Kurokawa, K.** 1977. *Metabolism in Architecture*. London: Studio Vista.
- Maki, F.** 2008. Investigations in Collective Form [1964]. In: Maki, F and Mulligan, M, (eds.), *Nurturing Dreams: Collected Essays on Architecture and the City*. Cambridge, MA: MIT Press. pp. 44–56. DOI: <https://doi.org/10.7551/mitpress/7596.001.0001>
- Mehaffy, M** and **Salingaros, NA.** 2013. What Does 'Resilience' Have to Do with Architecture? *Metropolis Magazine*, March. <http://www.metropolismag.com/architecture/resilience-architecture/> [Accessed 3-3-2019].
- Miyamoto, K.** 2016. Records of Projects in Nebama, Kamaishi (No. 2), Related to Public Housing for Evacuees and Reuse of Low-Lying Land. In: *ArchiAid, Archi+Aid Record Book, 2011–2016. Architects' Pro Bono Outreach Following 3.11*. Sendai: Ākieido. pp. 106–109.

- Okakura, K.** 1905. *The Awakening of Japan*. New York: The Century Co.
- Oshima, KT.** 2008. Postulating the Potential of Prefab: The Case of Japan. In: Bergdoll, B, et al. (eds.), *Home Delivery: Fabricating the Modern Dwelling*. New York: Museum of Modern Art. pp. 32–37.
- Prouvé, J.** 1971. *Prefabrication: Structures and Elements*. London: Pall Mall.
- Reynolds, JM.** 2001. *Maekawa Kunio and the Emergence of the Japanese Modernist Architecture*. Berkeley: University of California Press.
- Seike, K.** 1977. *The Art of Japanese Joinery*. New York: Weatherhill/Tankosha.
- Sendai, S.** 2014. Fukkō. In: Bonnin, P, et al. (eds.), *Vocabulaire de la spatialité japonaise*. Paris: CNRS Editions. pp. 132–135.
- Shibata, M and Koyasu, T.** 1874. *An English and Japanese Dictionary*. Tokyo: Nishusha.
- Sorensen, A.** 2002. *The Making of Urban Japan*, London: Routledge.
- Tange, K.** 1956. Creation in Present-Day Architecture and the Japanese Architectural Tradition. *Sinkentiku*, June: 25–33.
- Tange, K.** 1961. *A Plan for Tokyo, 1960: Toward a Structural Reorganization*. Tokyo: Kenzo Tange Team.
- Tange, K and Boyd, R.** 1962. *Kenzo Tange*. New York: G. Braziller.
- Totman, CD.** 1989. *The Green Archipelago: Forestry in Preindustrial Japan*. Athens: Ohio University Press.
- Totman, CD.** 1993. *Early Modern Japan*. Berkeley, CA: University of California Press.
- Ubaura, M.** 2018. Urban Planning and Reconstruction after the Great East Japan Earthquake. In: Greiving, S, Ubaura, M and Tesliar, J (eds.), *Spatial Planning and Resilience Following Disasters: International and Comparative Perspectives*. Bristol: Policy Press. pp. 55–76. DOI: <https://doi.org/10.2307/j.ctt1t8966q.10>
- Wright, FL.** 1932. *An Autobiography*. New York: Longmans, Green and Company.
- Yatsuka, H.** 2011. メタボリズム・ネクサス = *Metabolism Nexus*. Tokyo: Ōmusha. (Unpublished English translation provided by the author).
- Yatsuka, H.** 2012. The Social Ambition of the Architect and the Rising Nation. In: Kuan, S, and Lippit, Y (eds.), *Kenzo Tange: Architecture for the World*. Zurich: Lars Muller. pp. 47–60.
- Yamazaki, R.** 2010. *Nakagin Capsule Tower: Japanese Metabolist Landmark on the Edge of Destruction*. (DVD Video) Michael Blackwood Productions.
- Yeh, H, Sato, S and Tajima, Y.** 2013. The 11 March 2011 East Japan Earthquake and Tsunami: Tsunami Effects on Coastal Infrastructure and Buildings. *Pure and Applied Geophysics*, 170: 1019–1031. DOI: <https://doi.org/10.1007/s00024-012-0489-1>

How to cite this article: Genadt, A. 2019. Three Lessons from Japan on Architectural Resilience. *Architectural Histories*, 7(1): 16, pp. 1–16. DOI: <https://doi.org/10.5334/ah.393>

Published: 22 July 2019

Copyright: © 2019 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.

][Architectural Histories is a peer-reviewed open access journal published by Ubiquity Press.

OPEN ACCESS 