High Tech Attitude as a Corrective of Japanese Industrialised Housing: The Work and Discourses of Kohko Takahashi

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Introduction

Japanese architect Kohko Takahashi's housing design became associated with High Tech in the 1980s, when this relatively new term became commonly accepted as part of architectural vocabulary as referring to a certain emergent trend of the era. High Tech, as a term, was first circulated in journalism without clear definition, but according to Reyner Banham's posthumous text: *High Tech and Advanced Engineering* written around 1987, it "often seems to partake of the sense of Advanced Engineering as well as that of visual style and therefore can mean anything from 'slickly mechanistic presentation' to 'at the cutting edge of environmental technology [1]'". Takahashi's works dovetailed with this definition. They were marked by mechanistic idioms: the dry, inorganic textures of exposed steel frames, envelopes of fibre-reinforced plastic (FRP), autoclaved light-weight concrete (ALC), and other advanced materials. Nevertheless, she herself never considered her works as High Tech [2]. Her role as a notable agent of High Tech was, therefore, unintentional, since the trends her works followed emerged prior to their classification as High Tech.

Despite her personal dissociation from the label, prefabrication technology and the industrialisation of building elements were key concepts in both High Tech Architecture and Takahashi's works. She devoted her entire career to developing a personal design strategy which integrated adaptive design, construction method, manufactured or prefabricated materials, and equipment. This article explores Kohko Takahashi's discourses as well as works in the context of the industrialisation of Japanese housing and High Tech. Her commitment to this unique construction-design integrated approach was ascribed not only to her professional training in low-cost housing, but also to the epoch in Japanese housing during which she began her career. During the 1960s, the quantity of industrialised and prefabricated housing increased rapidly due to the influx work by newly established prefab home companies as well as the Japan Housing Corporation—a public institution mainly responsible for building blocks of flats. This exerted pressure on architects to reconsider their roles in housing design, influencing Takahashi's stance and ideologies as well. By drawing lessons from both her professional work on housing projects and her academic research, she attempted to find architectonic remedies for mounting issues recognised in industrialised housing, namely the low quality of structure and dull uniformity of design.

Takahashi dedicated her professional career to housing. After becoming an independent architect in 1962, she was involved in 17 housing projects, including her own home, *Kuda no ie*, 1983. Her career overlapped with the industrialisation of building equipment as well as the rise of prefab home businesses that established their own closed production systems on the basis of variable modules [3]. Her avidity for a modular coordination between the design of the entire house and the building elements that were rapidly becoming standardised and mass-produced led her to engage in the development of unitised fittings, such as prefabricated kitchen equipment and bathrooms through collaboration with manufacturers. Beyond her professional work on housing projects, she taught housing architecture and design at her alma mater—Japan Women's University—for 25 years until 1997, when she died of cancer at age 65. Her achievements have been revealed and catalogued by her students; however, the underlying logic behind her ideology and design strategy

and the architectonic features of her works, which encapsulated her tenets of home industrialisation, have rarely been examined in the context of Japanese housing production as a whole [4].

We focus particularly on Takahashi's view of the relationship between industrialised building elements, space, and humans. Her awareness of the interplay between these three components stemmed from her involvement in low-cost house prototyping in her mentor Kiyoshi Ikebe's laboratory in the University of Tokyo, which she joined in 1955, and where she remained for seven years. This article thus begins by defining Takahashi's basic design thinking and principles as constructed early in her career. This allows us to reveal how her construction-design integrated approach was shaped in tandem with, and in response to, the prefab home manufacturers' housing production practices as well as Ikebe's design principles. We will further shed light on the characteristics of her construction and architectural expression, and rediscover her High Tech characteristics.

Unitising Human Life

"I see no other architectural context in which my architecture can be positioned than Ikebe Laboratory's work" [5]. This remark on Takahashi's own architectural stance indicates that her design thinking was greatly influenced by how she absorbed and modified Kiyoshi Ikebe's methodology for housing. Ikebe's architectural production lab was established in 1949 and started with the design of minimal dwellings and the construction of case-study houses, reaching a total number of 95 before its 1979 closure upon his death [6]. He espoused technological determinism, assuming that home affordability and the rationality of domestic life could be achieved by reconciling the design and construction planning processes. His enthusiasm for creating ordinary people's houses stemmed from his desire to materialise and demonstrate his vision of democratised domestic life for the post-war era.

Ikebe's lab embarked on the invention of standardised, segmentalised building components and equipment in the late 1950s, when Takahashi began to engage in case-study housing projects. His attempt to promote the industrialisation of building elements was intertwined with his creation of the unique anthropometric scale of proportions, namely the General Module, to which Takahashi adhered throughout her career [7]. The General Module is a system that enables calculation and choice of modules suited to various design conditions. Assuming n = integral number and $P_1P_2P_3 = 0$ or 1, a module in centimetres (X_n) can be calculated with a formula below:

$$X_n = 2^n + 2^{n-1}P_1 + 2^{n-2}P_2 + 2^{n-3}P_3$$

It is further characterised by allowing multiple scales to be calculated in line with the size of a human body. For example, they are 64 cm ($n = 6, P_1 = 0, P_2 = 0, P_3 = 0$) and 96 cm ($n = 6, P_1 = 1, P_2 = 0, P_3 = 0$), which Takahashi frequently used in her housing projects [8]. In addition to Ikebe's attitudes towards the creation of new domestic life, this modular calculation system and its respect for human scale created a conceptual link between construction-focused design and everyday living which continued to influence Takahashi's works.

The rise of mass-produced housing also affected Takahashi's design thinking. From the late 1950s to the early 1960s, the emerging prefab home industry was propelled by post-war social circumstances, where calls for home industrialisation arose in response to severe housing shortages. This was compounded by the promotion of new materials such as light-weight steel, a government homeownership policy that expanded the residence fund loan system, and rapid economic growth. The initial reputation of brand-new prefab homes was dubious and unsavoury due to structural and practical problems, such as leakage during rain. These were attributed to deficiencies in technical know-how for implementing drywall and panel construction, which differed from the conventional post-and-beam construction characterised by earthen walls and mortise and tenon joints [9]. Nonetheless, the refinement of their prefabrication techniques as well as an increasing demand for housing steadily enhanced prefab home companies' desirability and ubiquity.

The name of Takahashi's design studio, Building Unit Design Office, founded in 1965, was the encapsulation of her design principles, moulded amid the ongoing industrialisation of building materials, components, and houses and echoing her critical insight into prefab homes. While she found something peculiarly appealing in these relatively new architectural entities, produced as if they were machines, she questioned the assumption behind the design of the prefab homes. She perceived that they were designed, prefabricated, and assembled by defining the whole house as a box encompassing a cluster of rooms. This cluster therefore became a conceptual unit for segmentalising and industrialising a building [10]. The underlying modelling concept, labelled the Building Element theory, which regarded any type of building surface as a basic constituent for the evaluation of structural features and the conditions of enclosed spaces of a building, prevailed from the late 1950s [11]. It was conceptualised by Yoshichika Uchida, based originally on British architects Richard Llewelyn-Davies's and D. J. Petty's discussion on the assessment of the performance of a building. They associated the complexity of building performance assessment with the rapid advancement of materials and methods, suggesting that it could be achieved by analytically examining the conditions of the components, mainly surface structural elements such as wall, roof, and ceiling [12]. This way of assessment implicitly presumed walled Western architecture, which differed from the wall-less space characterising the orthodox Japanese building, whose composition was determined by the relationship between the position of columns and arrangement of *tatami*-mat flooring. It can be considered that the Building Element theory facilitated the conceptual transformation of a design object from the wall-less to walled house.

In Takahashi's view, what ought to be segmentalised was not the wall, roof, or ceiling, but the connection between patterns of behaviour and spheres of action in domestic spaces [13]. To her, this connection was a basic 'unit' for design. She was explicitly aware that an object-oriented notion behind the design of the prefab homes, based conceptually in the Building Element theory, had the effect of making builders more cognizant of rationality of production and assembly of wall components, rather than practical usability of the resulting space [14].

Furthermore, Takahashi averred that poor module design deprived the prefab homes of the flexible use of domestic spaces. Her conviction was rooted in an analysis conducted in 1969, in which she compared spatial properties between the floor plans of 80 residences designed by architects and 84 industrialised houses and flats, including those of the Japan Housing Association [15]. One conclusion of this "spatial study" was that larger industrialised housing merely mean a larger version, with little variety in design, arrangement, and composition of rooms. She attributed the cause of this tendency to simplistic module optimisation where the relationship between the floor spaces of each room and the whole house was defined by an integral multiple of around 90 cm, a basic dimension widely used for industrialised housing [16]. To her, this finding was evidence of the superiority of the General Module, which allowed architects to calculate and flexibly choose narrower or wider modules suited to their projects.

While being influenced by the modernist Ikebe, Takahashi's attitudes towards segmentalised, standardised, and manufactured building elements elucidated her personal reaction to modernism in architecture. The thought that a house and its fixtures and fittings surrounding a human body were tools to aid people in the production of their daily lives; from meals to cloth to furniture, was shared by both Ikebe and Takahashi, evoking William Morris's conceptualisation of craftmanship and the socialistic creed that underlaid the Arts and Craft movement [17]. In Takahashi's eyes, dwellers of the prefab homes were passively crammed into and domesticated by these boxes for consumption [18]. Her ideal of home industrialisation denied a loss of individuality, and built upon the respect of diversity in design, and the use of space. To Takahashi, prefabricated building materials, components and amenities were also tools to empower architects, engineers, prefab home companies, and other related manufacturers. She believed that the free use of prefabrication techniques was a means to enable the standardisation of industrialised housing in performance which did not result in homogenisation in design and planning; often seen as the main ramification of modernism [19].

Standard Humans

Takahashi's search for diversity in industrialised housing was not unrelated to a growing social demand on dwelling in the late 1960s, when her Building Unit Design Office rose to prominence. By this time, the advancing prefab home businesses and Japan Housing Association had ostensibly relieved housing shortages and population pressure in the metropolises. The uniformity of the indoor as well as urban built environments offered by monotonously standardised prefab homes and flats, however, raised the issue of how diversified needs for the quality of housing could be appropriately answered. Whether discussing industrialised or purpose-built housing, this was not a challenge for her mentor, Ikebe, who started his career just after WWII. He viewed the house as an arena; a sort of public display where architects expressed and incarnated their own visions of democratised family life and the daily life of the future. This strong sense of purpose in designing for the future positioned him as a vanguard of modern housing design, often leading him to reject clients' more conservative requests [20].

While clearly influenced by Ikebe's didactic attitude, the social and architectural ethos of the 1960s steered Takahashi in a different direction. She tried to determine 'units' in clients' daily lives through communication with them, believing that such a process embedded in her construction-design integrated approach led to the diversification of housing design, and ultimately the development of the solution for the betterment of industrialised housing [21]. However, this logic brought a new challenge for her: how to process the diversity of realities and personalised 'units' in order to be able to define consistent basal conditions for proposing a widely applicable model of industrialised housing?

Such methodological uncertainties led Takahashi to take a psychological and structuralist perspective to the issue. She presumed that the nature of "standard humans" in her terms, or the intrinsic characteristics of people (implicitly Japanese in her assumption) in the appropriation of space could be a point of reference for designing industrialised housing [22]. One of her research objects was the personal space created by a person's comfortable distance with others. Her psycho-engineering study made her realise that a more distinctive and psychological barrier between boarded and *tatami* spaces existed in a typical Japanese house. Through experimentation to determine the measurable extent of this intangible barrier surrounding the body, she revealed that proximate distancing was more tolerant in a conventional seating posture—sitting down on *tatami*—than in contemporary one—sitting on a chair [23]. The ways that people habitually occupied certain spaces in the house were also of academic interest to her. The dynamic material relations between "standard humans" and designed spaces were disclosed by investigating time-space patterns of occupancy according to differences in age, sex, and family structure [24].

Takahashi's construction-design integrated approach was not structurally dependent on the compartmentalisation or clear record of the personalised locale where the "standard human" felt comfortable residing. Rather, her approach was attuned to the creation of a wall-less interior with roughly separated rooms entirely covered with a large roof, or orchestrated by corridors that ensured unity and spaciousness. Whoever the clients were, she unvaryingly adopted this one-room system, which harkened back to Ikebe's ideology. His way of materialising equality and democratisation in family life was the minimisation of the number of interior walls—particularly one separating the dining room from the kitchen. In his eyes, the segregation of kitchen and dining in the conventional Japanese house symbolised a historical, feudal hierarchy that distinguished between males and females, and older and younger members of a family. His ideal of a post-war, democratised family was manifested in the design of a centred kitchen-dining space surrounded by adjacent, roughly-partitioned rooms. This formed the basis for one of his unique interior architectural signatures [25].

Takahashi added new meaning to this one-room system. Its open-plan interior was agreeable to her presupposition that as well as individual person's preference, the nature of "standard humans" in the use of domestic spaces would change over time [26]. In her view, a house should be designed to avoid any friction between built spaces and changes in the ways that dwellers appropriated and personalised them. In other words, the one-room system was the solution to the omnipresent contradiction caused by a conflict between the immutability of a designed space, and the constant

transformation of peoples' ways of life and thinking. It had much to do with her design philosophy of not over-designing the interior arrangement and finishing. She believed that a designed house ought to be somewhat imperfect and unplanned leaving less elaborately designed margins for flexibility in the use of domestic spaces [27].

Handcrafted Prefab

In her early projects, the expression of spatial flexibility exemplified Takahashi's quest for the ideal design of the one-room system. One of her works in the 1960s, I House, was designed for a particular client, but embodied her societal design purpose. It was assumed that the same house could be mass-produced, and were suited to any dwellers, or "standard humans" [28]. This narrow single-storey house was built on the concrete foundations, running from west to east, and clearly manifesting her enthusiasm for the use of her favourite materials: H beams framing its entire, container-like geometry, and ALC panels that created uniformity for its outer surfaces (Fig. 1). The house featured five segments (four on the north façade, and one on the south) protruding from the exterior geometry of the house, creating interior alcoves which contained storage, closets, and the built-in kitchen sink (Fig. 2). Theoretically, the use of these alcoves was interchangeable in accordance with dwellers' needs. The south-facing kitchen protrusion was not composed of a prefabricated, integrated kitchen system due to a lack of common availability, but was rather meticulously designed by Takahashi with standardised kitchen fittings, such as a stainless sink and tap (Fig. 3). The interior of this house comprised the nursery, a Japanese-style room without *tatami*, the suite of the kitchen-dining room and living room, and the more orthodox *tatami* space, arranged in a row and partitioned not with structural walls, but with wall-like shelves. These movable interior surface elements were, in theory, both removable and changeable. In her view, the long-span H beams allowed the domestic spaces to be freed from any structural wall by which the dwellers' use of space might be restricted.

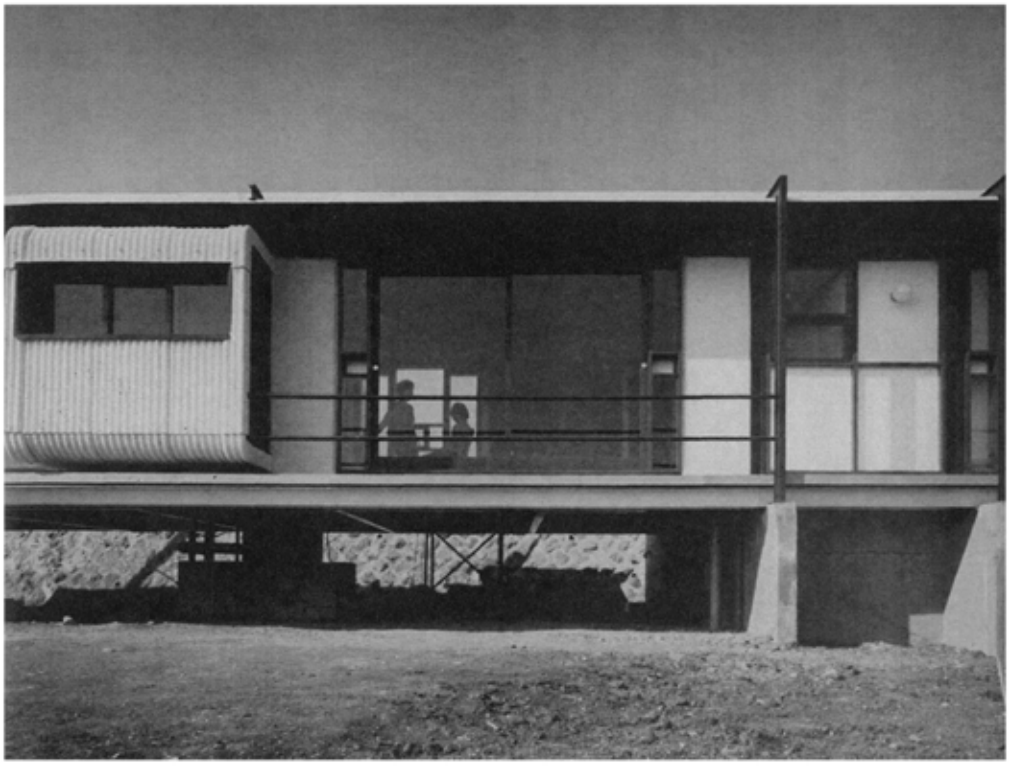

Fig. 1. Exterior of I House. Photo by Tomio Ohashi from Architectural Culture, December 1968, p. 71.

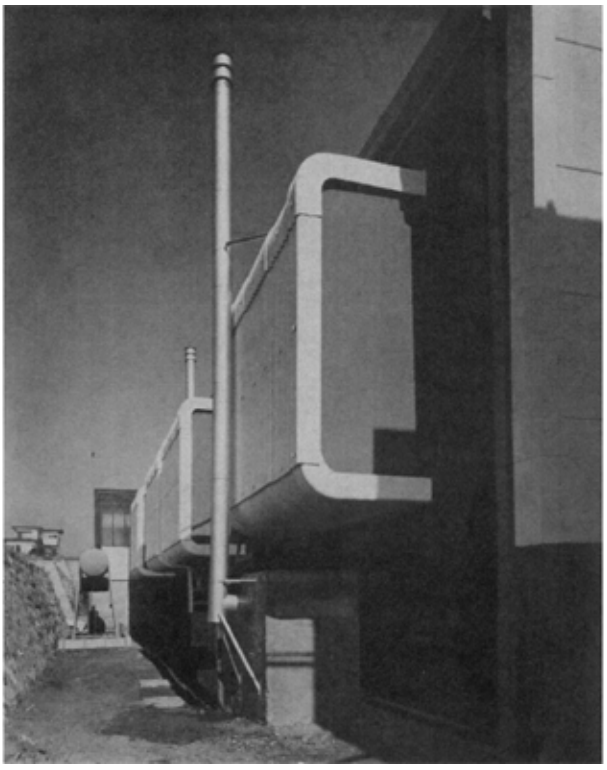

Fig. 2. North-facing storage and closet segments of I House. Photo by Tomio Ohashi from Architectural Culture, December 1968, p. 73.

Fig. 3. Kitchen alcove of I House. Photo by Tomio Ohashi from Architectural Culture, December 1968, p. 76.

A decade later, I house experienced major improvements proposed by Takahashi, albeit in an unprogrammed way. An arch-shaped roof was added to create attic rooms in this originally flat-roofed, one-storeyed house (Fig. 4), and the ground floor was newly equipped with a larger, integrated kitchen system, instead of the previous kitchen segment that was completely removed [29]. Concurrently, she revisited other work of hers for extension and reconstruction, which made her realise the necessity of a new design approach, whereby the difference in life spans between the fabric of a house and equipment was provisioned for in design, and therefore easily manageable [30].

Fig. 4. Arch-shaped roof of reconstructed I House. Photo by Tomio Ohashi from Architectural Culture, August 1979, p. 52.

From the 1970s onward, the literal sense of the one-room system became the common spatial idiom characterising Takahashi's works. The vaulted ceiling of her house, *Kuda no ie* embraced the daily life of her two-generation household and was framed by the array of steel pipes, from which the inner walls of lauan plywood were structurally divided (Figs 5-6). The birdcage-like structure of this house, complete in 1983, was the result of the application of timber balloon framing, and the tube pillars—with a diameter of 60.5 mm—were erected at 96 cm intervals, according to the General Module [31]. The unadorned atmosphere of the interior, characterised by exposed steel pipes and unpainted plywood, mirrored her ideology that the quality of unfinished and unvarnished building materials was an undesigned element with which dwellers were intended to envision themselves as the catalysts of future change, rather than subjects of the perpetuity of materiality. In fact, the transformation of the physical properties of zinc plates that covered the entire roof and exterior walls of the first floor were anticipated as part of the design (Fig. 7). She looked forward to seeing the process of chemical reaction caused by exposure to rain and wind, which was expected to bring the change of its colour from metallic silver to sober, charcoal grey [32].

Fig. 5. Vaulted ceiling of Kuda no ie. Photo by Tomio Ohashi from Architectural Culture, July 1983, p. 63.

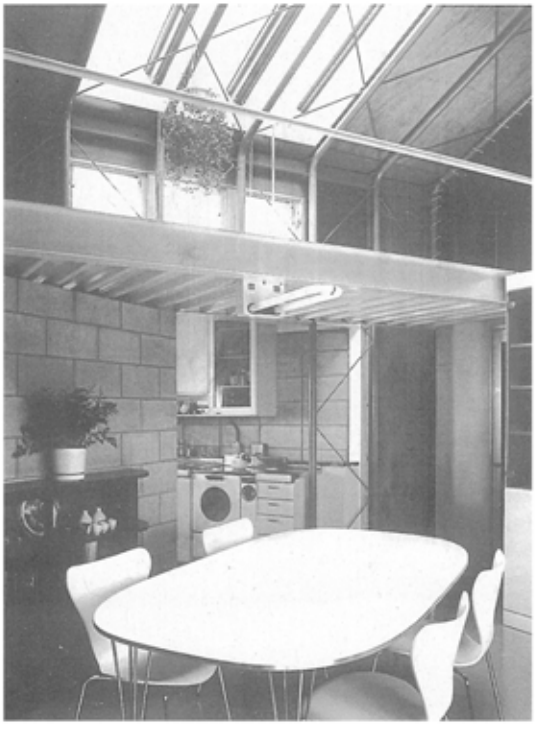

Fig. 6. Kitchen-dining area of Kuda no ie. Photo by Tomio Ohashi from Architectural Culture, July 1983, p. 66.

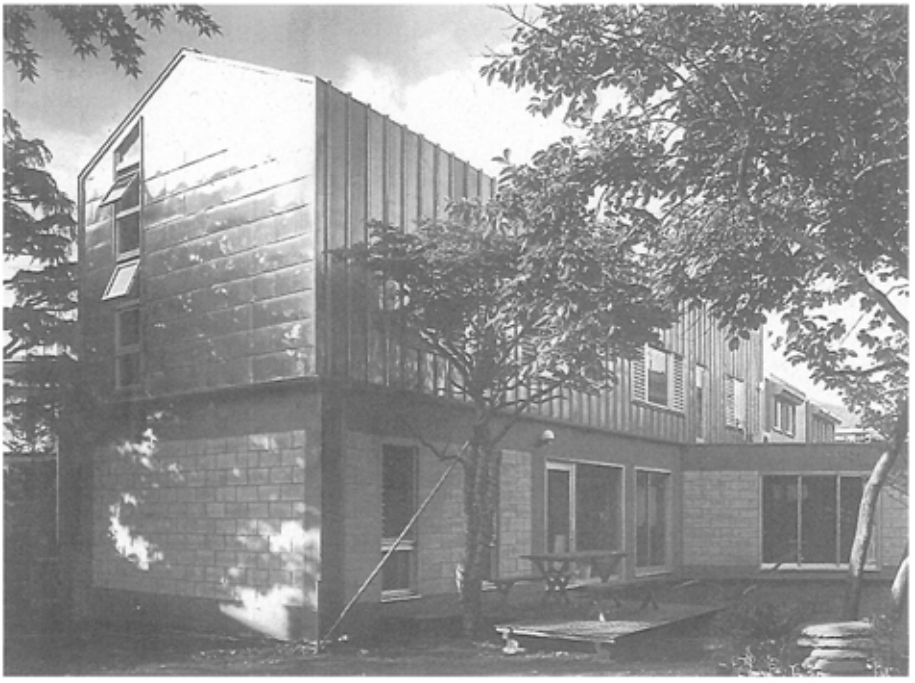

Fig. 7. Exterior of Kuda no ie. Photo by Tomio Ohashi from Architectural Culture, July 1983, p. 61.

A narrow passage to the site conditioned Takahashi's construction-design integrated approach, requiring a building method without the use of any heavy machinery. This constraint in the construction of *Kuda no ie* led her to utilise manufactured concrete blocks, that were both multifunctional and portable, to create the structural walls of some parts of its ground floor [33]. These exposed concrete block surfaces were the amalgam of her holistic consideration of a range of different factors; the design and structural characteristics of the building, material availability, construction procedures, and masonry work to build them. Her description of *Kuda no ie* as "handcrafted prefab" grasped the essence of her construction-design integrated approach, positioned as the antithesis to the prefab home industry's housing production [34]. On the one hand, the prefab homes were the assemblages of building elements exclusively designed and manufactured as part of a catalogue of the companies' closed systems, while on the other hand, Takahashi rarely took such an object-oriented attitude, but rather enjoyed the process of designing and crafting in a DIY fashion, which created the freedom of choice through the use of prefabricated materials and equipment [35].

Presumably, Takahashi's masonry approach derived from the S House project, 1981 (Fig. 8). This house presumed that the parents' and son's families lived separately on the same parcel of land, thus the building consisted of two isolated wings roughly connected by substantial steel frames shaping their geometries, and a connecting corridor that functioned as the shared library [36]. The structural walls of this library corridor were built with exposed concrete blocks, whose inorganic quality served to accentuate the warm and affectionate relationship between the two households. The fact that the client, fascinated by Ikebe's design philosophy, had previously lived in his work for about two decades, led naturally to the adoption of the one-room system in both structural and ideological terms. Contrary to the steel pipes of *Kuda no ie*, no structural columns of S House were exposed in the interior. This house was rather marked by the exposed truss structure bearing the large roofs as—at least, in Ikebe's and Takahashi's views—the symbol of democratised family life under which all members of the family would congregate (Figs 9-10).

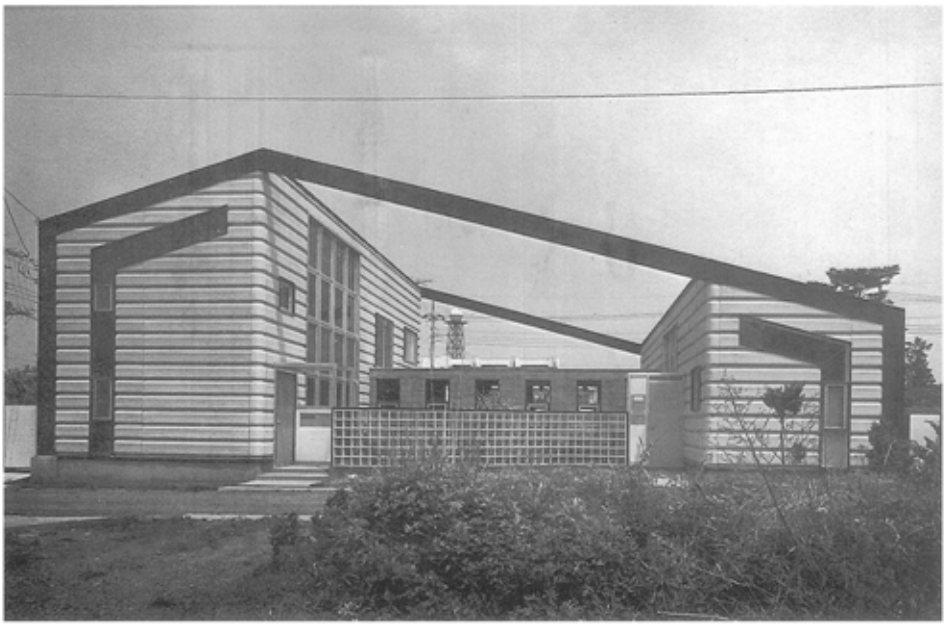

Fig. 8. Exterior of S House. Photo by Tomio Ohashi from Architectural Culture, August 1982, p. 56.

Fig. 9. Kitchen-dining area of S House. Photo by Tomio Ohashi from Architectural Culture, August 1982, p. 61.

Fig. 10. Exposed roof truss of S House. Photo by Tomio Ohashi from Architectural Culture, August 1982, p. 58.

The large windows to let daylight into these open ceiling spaces echoed an inner conflict Takahashi began to experience in pursuing her design policies: the use of manufactured building materials and equipment, and the application of Ikebe's General Module. She believed that the industrialisation of building products assured a greater variety of choice, and thus increased the degree of freedom in architectural design. However, the proliferation of these factory-made items, particularly aluminium frames that became popular during the 1960s, made her realise the gap between the ideal and the real. As with other standardised fittings, the sizes of aluminium frames were generally defined by the conventional system of measurement, whose basic unit was 30.3 cm. In the case of S House, the design module set according to the General Module was 32 cm; this dimension was not necessarily advantageous for coordinating the fabric of the whole house with manufactured building materials, fixtures, and fittings [37]. In addition to the limitations prescribed by available prefabricated units, both colour and texture were increasingly limited in manufactured building products, thus dictating many aspects of housing design. [38]. In S House, or the "handcrafted prefab", she relied—perhaps, reluctantly—upon expensive, custom-made aluminium frames suited to the General Module [39].

Conclusion

While she rarely linked her own works with it, Reyner Banham's assertive, albeit incomplete, theorisation of High Tech was well aligned with the main features of Kohko Takahashi's housing design. In his *High Tech and Advanced Engineering*, Banham described it "as an attitude and as a body of design practices" that espouses advanced engineering, and does not see "buildings simply as passive shelters against the elements, but rather as complete and active environmental systems" [40]. Takahashi works, characterised by her construction-design integrated approach, had the same architectonic features. To optimise this approach that presumed the unity of the exterior and interior of a house, she took a phenomenological and structuralist perspective on 'units', or behavioural connections of spaces-segmentalised

elements of a building with both clients and the "standard humans" in mind. These two parties of inhabitants were seen as the invisible cast in dwellings tailored to individuals' needs. While she believed that such a methodology was a means to bring diversity to the design of prefab homes, and better usability in their domestic spaces, her commitment to Ikebe's General Module precluded her from fully capitalising on the value of home industrialisation: affordability in housing. The incompatibility between the General Module and the conventional units of measurement that defined the sizes of most standardised, manufactured materials created inconvenient remnants and dysfunctional modules [41].

As Banham regards High Tech as "an alternative Modernism", both Western High Tech architects and Takahashi embraced a functionalist rationale underlying Modernism, and challenged its consequences [42]. To Takahashi, her High Tech attitude was a corrective of the malady of architectural mass production as well as standardisation: the homogenisation of industrialised housing that prevented dwellers from being unfettered in the appropriation and production of spaces. Likely because her dedication to post-war Japanese housing revolved around the design of detached houses for single families, she hoped more for 'interactions' taking place around the body—harmony between building components, fixtures and fittings, and humans. As the free use of less-elaborately designed spaces was thought of as a path to a life of creativity and subjectivity, in her view, the plain, unornamented quality of exposed steel frames, FRP, and ALC boards comprising her houses were a sort of 'designed' canvas which dwellers were intended to personalise and familiarise themselves with in the course of inhabiting the spaces [43]. In short, these visual properties were the manifestation of her functionalist reliance on ergonomic analysis of personal space and spatial occupation as well as new factory-made materials, prefabricated building elements, and equipment. Her construction-design integrated approach encapsulated her unintentionally High Tech attitude toward the relationship between ever-evolving industrialised building materials, modern amenities, and humans in Japanese housing.

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[29] K. Takahashi, 'Jūnenme no zōkaichiku: I tei to Y tei' [Extension and Reconstruction after Ten Years: I House and Y House], *Architectural Culture*, August 1979, pp. 50-63.
[30] Takahashi, (Note 29) p. 59.
[31] 'Kuda no ie', *Architectural Culture*, July 1983, pp. 61-8.
[32] ibid., p. 65.
[33] ibid.
[34] ibid.
[35] Matsumura et al., (Note 3) pp. 15-6.
[36] K.Takahashi, 'Nijūnenme no sekkei' [Design after Twenty Years], *Architectural Culture*, August 1982, pp. 55-62.
[37] ibid., p. 60.
[38] K.Takahashi, T. Koizumi and S. Kitada, 'Jūtakuyō buhin wo tsukatte omou koto' [Our Opinions on the Use of Manufactured Building Products], *Architectural World*, vol. 25, no. 8, 1976, pp. 67-72.
[39] Takahashi, (Note 36) p. 60.
[40] Banham, (Note 1) pp. 235, 244.
[41] Japan Women's University, (Note 4) pp. 54-7.
[42] Banham, (Note 1) p. 245.
[43] Takahashi, (Note 2) p. 137.