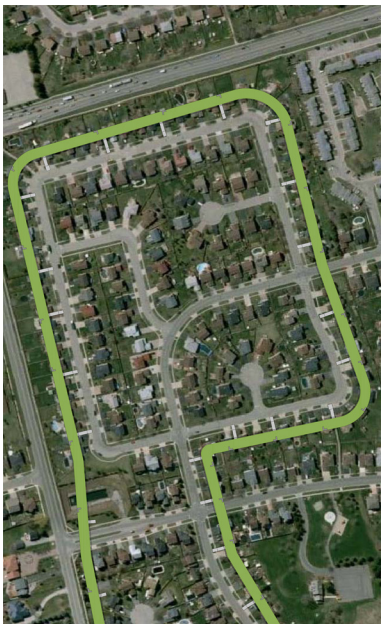
Flexibility and life cycle are important considerations for all buildings, but especially for community-centred primary schools, since the demographics of a neighbourhood can fluctuate widely over a short time period. Adaptability must be taken into account by the architect, and can be done more or less successfully depending on the arrangement of space and choice of structure. The purpose of this investigation is to examine buildings which could be considered 'flexible', especially those which have educational programming, in an effort to define what qualities make a building adaptable, and what qualities make a successful school. The choice of material will be discussed in its relation to the facilitation or hindrance to adaptability, with the goal of isolating the useful qualities of steel for adaptable buildings. The projects addressed include Tschumi's Le Fresnoy, the CLASP system of school-building, and designs of the high-tech era, most prominently Cedric Price's Potteries Thinkbelt. All demonstrate successful adaptable characteristics that influenced the design of *s-bridge*.

Le Fresnoy was an entertainment complex from 1905 to 1970, containing a cinema, dance hall, roller-skating rink, and numerous eateries and gaming halls; in the early 1990's, the abandoned complex was chosen to be transformed into a world-class school for the arts[1]. Le Fresnoy presents a typology of the long-span box as a basic adaptable unit. More specifically, it expresses the condition of 'boxes within a box': one large volume which has the capacity for services, circulation, and informal space, within which are inserted other, specialized boxes. In the case of Le Fresnoy, placing an exoskeleton over the existing assembly buildings saved the cost of restoration, facilitated the installation of the complex HVAC needs of the school, and created an element of continuity bridging between heterogeneous elements[2]. It also, most importantly, left a residual space- a "space where anything might happen; a place of experimentation; a place located on the margins"[3]. This informal space was essential to the fundamental value of the school, which was to prioritize cross-over and discussion between different forms of art[4]. In this case,

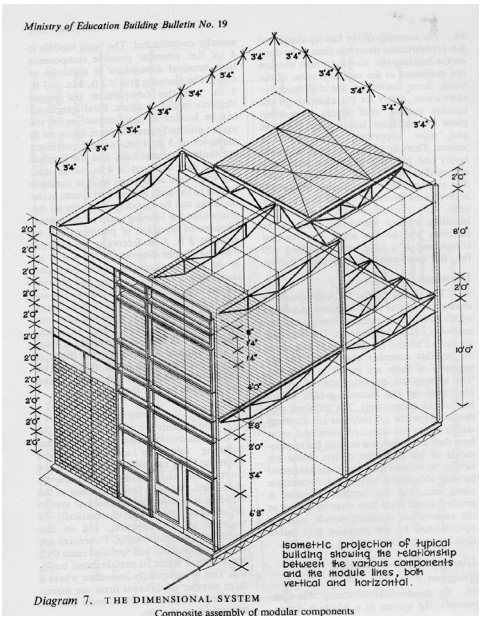
The use of steel elements in Le Fresnoy allows the character of the old buildings to remain apparent.[5]

1 Bernard Tschumi and J. Abrams. Le Fresnoy (New York: Monacelli Press, 1999) 25.
2 Ibid., 39
3 Ibid., 44.
4 Ibid., 21
5 Image source: Bernard Tschumi and J. Abrams. Le Fresnoy (New York: Monacelli Press, 1999)

steel was an obvious choice. The three-dimensional trusses have the capability to span long distances while still providing voids for the insertion of services. Since the circulation walkways are hung from the trusses, steel was the only choice since its strength in tension was required. The use of steel elements, especially the slender tension rods, adds to the aesthetic lightness of the structure and allows the character of the older buildings to remain apparent. The association and meaning of 'hangar' was also important to the conception of the project- a volume which, by its size and scale, creates a new world[6]. Steel is the only material that has enough strength yet visual lightness to realize the construction of hangars. Programmatically, Le Fresnoy and *s-bridge* are very different; a post-secondary institution requires less security and exists at a larger scale than a primary school. The concept of an overall organizing principle that can link many disparate programs, however, is one that is applied to both projects.



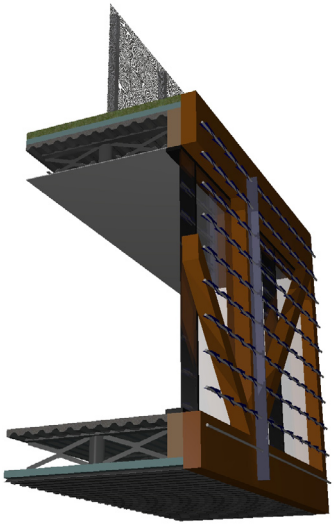
Site plan of *s-bridge*. One system links many disparate community services.



Components and assembly of the CLASP system.[13]

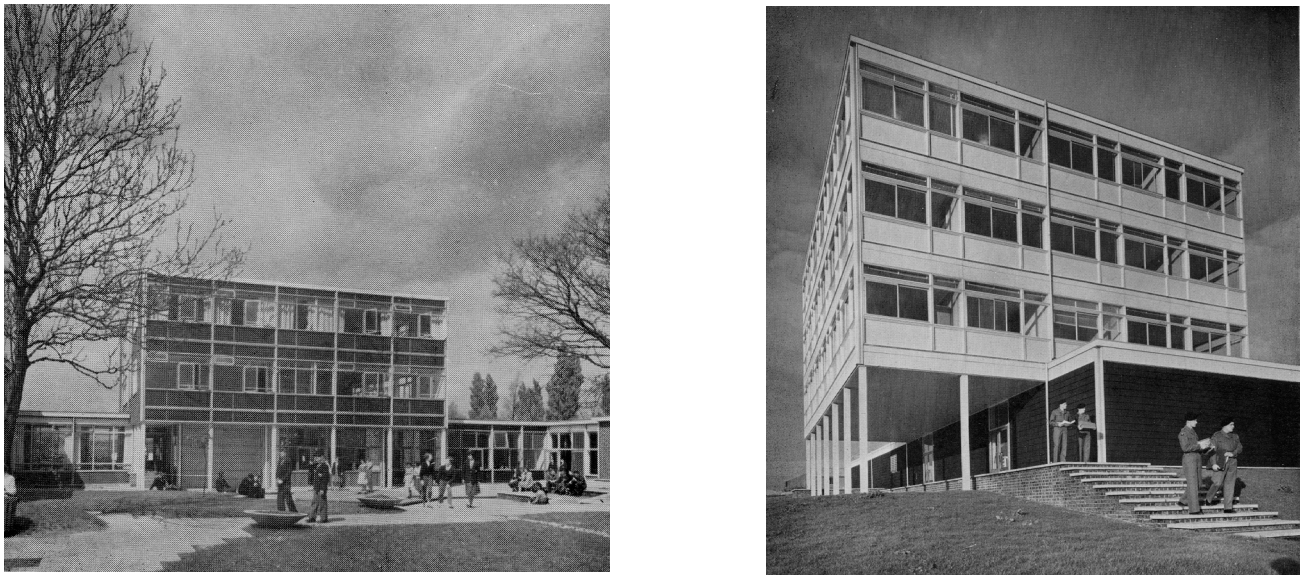
The CLASP system of school building is very different from Le Fresnoy in that it was designed specifically to be applied to primary schools. CLASP was developed in Britain after the second world war[7]. Industries right after the war were geared to light manufacturing and there was a severe shortage of skilled labour in the construction industry[8]. These facts plus the need for relatively cheap, high-quality educational space led to the development of a standardized system of components which could be fabricated in factories, taking advantage of wartime factories' capacities for assembly in controlled conditions[9]. A steel pin-jointed frame was chosen for the CLASP system because of its strength, ease of on-site assembly, and ease of prefabrication[10]. A CLASP school is built on a site-cast slab-on-grade, on top of which a steel frame is erected then infilled with windows and cladding units; all modules are based on a grid of 3'4" x 3'4"[11]. The roof is low-slope or flat and covered with timber roof deck units[12]. Schools are generally no more than 3 stories tall. The factory-made

6 Bernard Tschumi and J. Abrams. Le Fresnoy (New York: Monacelli Press, 1999) 39.
7 Great Britain Ministry of Education. Story of Clasp (1961) 31.
8 Ibid.
9 Ibid.
10 Ibid., 11
11 Ibid., 31
12 Ibid.
13 Image source: Great Britain Ministry of Education. Story of Clasp (1961) 33.



Floor and roof joists, decking, trusses, fencing, and sun shading are all modules that make up *s-bridge*.

components include the steel frame units, pre-cast concrete cladding, aluminum sliding windows and ventilating louvres, HVAC equipment, partition walls, and sanitary fittings[14]. This system proved especially efficient for its circumstances. The volume of school space needed meant that components could be prefabricated in large quantities and used for many projects, thus reducing their cost. The capacity for manufacturing was already in place, and the extensive prefabrication reduced on-site labour. The system was adapted for non-educational building as well; office buildings, a police headquarters, and a clinic are some examples of non-institutional CLASP projects[15]. Today, however, there is an abundance of skilled labour and an economically slow construction industry; the relevance of a system such as CLASP is not as great. What is important to recognize in the CLASP projects is the flexibility of a system of standardized components which can then be assembled in a multitude of ways; this concept is applied to *s-bridge*.



A school (left) and an office (right), both fabricated using the CLASP system.[16]

Using a system of modules that can be moved or replaced, both the CLASP system and Cedric Price's Kent Interaction Centre create spaces that can adapt to changing programmatic and social needs. Like Le Fresnoy, the Kent Interaction Centre employs a system of specialized modules united under one envelope; however, the flexibility of this project is further enhanced by its capacity for physical movement[17]. The

14 Great Britain Ministry of Education. Story of Clasp (1961) 31.
15 Ibid.
16 Image sources: Great Britain Ministry of Education. Story of Clasp (1961) 41,42.
17 R. Kronenburg. Flexible : Architecture that responds to change. (London: Laurence King, 2007) 59.

construction is comprised of a steel frame, prefabricated components such as walls, stairs, and service modules, and traveling cranes that use the steel frame as rails[18]. Based on the users' input, the cranes relocate the components within the frame. This concept allows for complete adaptation and new uses within a time period of minutes. Physical movement of program was not considered as a high priority for *s-bridge*, since the transformation of a neighbourhood happens over a period of years. As well, Price designed the Interaction Centre in order to explore the possibilities of dynamism in architecture; he noted that if the components remained static for a certain amount of time, a computer system would take over and program the cranes to reconfigure their locations[19]. He seemed to foresee that the motion might be unfamiliar or uncomfortable for the users. In the case of *s-bridge*, when the primary users are young children, an environment that constantly changes could seem frightening. Large reconfigurable components are not desirable, and not necessary, for flexibility.

Price's design for a "higher education facility", Potteries Thinkbelt, reuses an existing railway infrastructure to support a university for 20 000 students[20]. By addressing not only the programmatic needs, but also the needs of the surrounding community, Price builds inherent sustainability and flexibility into the Potteries Thinkbelt. The project aimed to regenerate the brownfield site of the Potteries in North Staffordshire, which has a span of over 160km, embrace new technology, and to revitalize the economy of the area by infusing the industries with intellectual power and experimentation[21]. Flexibility was also achieved through the use of mobile classrooms, which were integrated into "railbuses" moving from site to site along the Thinkbelt. Equipment and goods were transported along the same rail network; since education was linked with industry,

Sketch by Price of the Potteries Thinkbelt.[22]

18 R. Kronenburg. Flexible : Architecture that responds to change. (London: Laurence King, 2007) 61.
19 Ibid.
20 Ibid., 60
21 S. Hardingham and K Rattenbury. Cedric Price: Potteries Thinkbelt. (Abingdon: Routledge, 2007)
22 Image source: http://www.arch.cuhk.edu.hk/server2/m08/wlng/potteries%20thinkbelt/

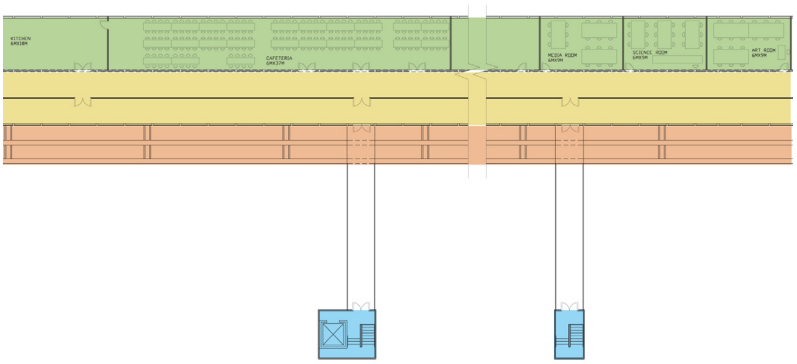
View of *s-bridge*.

the classrooms had to be moved from factory to factory in order to support ongoing research[23]. Price's designs for housing and additional infrastructure prioritized steel as a building material because components could be premanufactured; he envisioned much of the construction executed by non-construction sectors such as the light engineering and motor manufacturing industries[24]. The sheer scale- housing for 40 000 people- required systems that could be easily assembled and replaced. The mindset of Price and the Potteries Thinkbelt has a large influence in *s-bridge*. Although unbuilt, the Thinkbelt represents the possibility and potential viability of integrating transportation and education. In the case of *s-bridge*, this integration offers the opportunity to provide to the suburbs an element that they lack. Also, the aesthetic and functionality of the steel components that are used in the Thinkbelt influence the construction of *s-bridge*, which likens to a bridge or roller coaster more than to a building.

Other buildings from the high-tech movement such as the Lloyd's building by Richard Rogers and the Centre Pompidou by Rogers and Piano provide important space planning ideas. Both of these projects distinctly separate circulation from programmed spaces. In the case of the Lloyds building, vertical circulation cores, framed in steel, are pulled to the outside, in the reverse of a typical office building. This permits greater flexibility within the floor plate and allows the circulation to be updated while leaving the main structure untouched. *S-bridge* also separates vertical circulation, horizontal circulation, and program spaces, thus ensuring security for students of the school and efficiency of movement within the system.

23 S. Hardingham and K Rattenbury. Cedric Price: Potteries Thinkbelt. (Abingdon: Routledge, 2007)
24 Ibid., 18

View of Lloyd's building showing exterior vertical circulation cores.[25]



Partial plan of *s-bridge*, showing program spaces (green), horizontal pedestrian circulation (orange), horizontal vehicular circulation (red), and vertical circulation (blue)

The projects that have been discussed all are flexible in one or many ways, and all use steel for a structural system; however, each has a distinct set of priorities that make each construction unique. Even the most universal baseline, the idea of education, changes according to the context. In the same way, the priorities for *s-bridge* shape and transform existing concepts of flexibility and adaptable architecture into a system that aims to enhance suburban living and create a space that can be appropriated by all members of the community. The idea of education has been updated and tailored to meet the needs of the 21st century.

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25 Image source: www.essential-architecture.com/LO/LO-016.htm