arq (2016), **20.4**, 357–369. © Cambridge University Press 2017

A Spanish campus of the early 1970s was designed using a system-oriented approach, founded on the interaction of three systems: functional, constructional, and urban.

Project and system: Instituto Politécnico Superior de Valencia

Raúl Castellanos Gómez and Débora Domingo Calabuig

The architecture of end-products is one thing, the architecture of processes is another, but in fact the difference between the two is a matter of emphasis, for no architecture can completely disregard the object, and all architecture, no matter how static, functions in some way. As a rule, a clash of categories underlies this polarity: whereas form is the basic attribute of the architecture of things, function (or more generically, the programme) is the basic attribute of the architecture of the behaviour of things.[1] The unknown quantity that the architectural project reveals is not only 'how it must be', but also 'how it must work' [1, 2].[2]

This might seem irrelevant in the case of a simple architectonic project such as a medium-sized building with unchanging, well-defined requirements, but it rises to a certain prominence when the architect is obliged to deal with complexity and uncertainty. Hence, the greater the number of interconnected variables in a programme or the greater the likelihood of them changing over time, the more useful a system-oriented approach is for the architect.[3] Indeed, the science of systems was, according to its instigator and ideologist, Ludwig von Bertalanffy, a new approach developed in response to complexity and 'the requirement to cope with a new sort of problem'.[4] The acclaimed scientist's first version of the general system theory dates from 1948 – the same year as Norbert Wiener's *Cybernetics* – but it was only several decades later that it began to influence a type of architecture accustomed to audacious transfer mechanisms.[5]

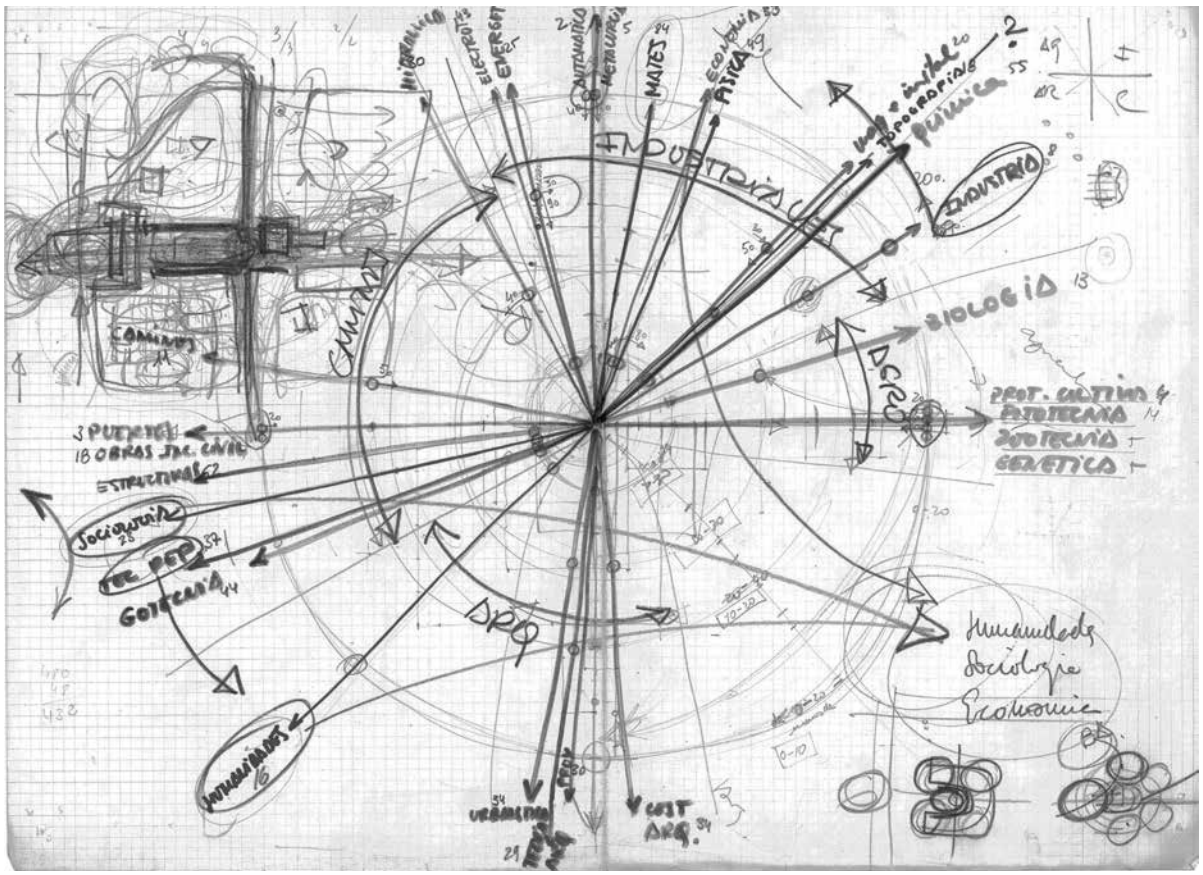
In 1962, Shadrach Woods referred repeatedly to the 'web system' concept and demanded that 'a whole which is greater than the sum of the parts' be created for architecture and town planning, i.e an interwoven system that precedes all plastic expression and provides a physical and conceptual framework for the organisation of functions.[6] Nevertheless, the most structured reflection about



1 L35 Arquitectos, competition entry for the Instituto Politécnico Superior de Valencia, 1970.

doi: 10.1017/S1359135517000045

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press



2

2 First topological chart for the Instituto Politécnico Superior de Valencia, n.d. Radial arrows show departments (Mathematics, Economy, Physics… starting top right and going clockwise); Academic degrees are indicated by gradient arrows (Industrial Engineering, Agricultural Engineering, Architecture, Civil Engineering… starting top right and going clockwise)

the theory of systems from an architectural stance is probably that of Christopher Alexander who, in 'Systems Generating Systems' said, 'The designer becomes a designer of generating systems – each capable of generating many objects – rather than a designer of individual objects'.[7] Indeed, by the late 1970s the efforts made to replace the concept of the building as a static, set form object, with an open, flexible system, were obvious.[8]

The original intention of systems theory was to do away with excessive specialisation in the sciences. In a manner deliberately reminiscent of the structuralist thinking of Claude Lévi-Strauss, von Bertalanffy said that understanding required not only the elements but also the relationships between them.[9] Meanwhile, post-Second World War architects came to realise how appropriate this theoretical approach was for dealing with the major programmes promoted by the mass society. One such programme – the university – was undoubtedly a paradigmatic case because of its shift, from the 1960s onwards, towards the interdisciplinary focus not unlike the approach championed by von Bertalanffy for science. The boundaries between different disciplines gradually became blurred, helped by the creation of new architectonic structures able to guarantee and foster internal relationships between the different parts while remaining open to the possibility of future modifications.

It is no coincidence that it was precisely the project for a university that Alison Smithson chose to illustrate one of the theoretical principles in closest proximity to the theory of systems established on the basis of the architecture of Team 10: *mat-building*. The Freie Universität Berlin (1963–73) by the architects Georges Candilis, Alexis Josic, and Shadrach Woods, is a good example of this sort of architecture 'based on interconnection, close-knit patterns of association, and possibilities for growth, diminution, and change'.[10] The departmental structure that characterised this university and many others built in the 1970s featured a fully-fledged system, for the interwoven relationship between its different parts reflected the ultimate aim of higher education: the free and open exchange of knowledge.

It was at this point that European universities began to welcome students from a broader spectrum of the population. Education reform spread across the continent and many competitions were held for the design of new universities. University education was democratised in Spain too: the 1969 White Paper published by the Ministry of Education and Science enshrined education as a vehicle for social mobility and promoted the creation of new universities in Spain's main cities.[11] That same year the controversial competitions for the scheme design of the autonomous universities of Madrid, Bilbao, and Barcelona were held, followed shortly afterwards by the competition for the Instituto Politécnico Superior de Valencia (hereafter IPSV).[12]

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

Although any of the above-mentioned examples could demonstrate the application of the system theory to university architecture, it must be said that the project submitted by the architectural firm L35 Arquitectos of Barcelona for the IPSV competition had certain particularities that deserve a closer look.[13] It barely strayed from the tender requirements when actually built, and the project documents and some of the main drawings demonstrated the architects' unshakable faith in a systems approach. The architects said, for example, that their proposal 'contradicts the classical theory of the project as the physical embodiment of one programme of requirements'[14] and yet, on the contrary, that 'it aims for a valid structural synthesis independent of said programme',[15] and then went on to say that:

> *All this means that the programme/solution correspondence is not one-to-one but a bijective relationship between multiple elements in which it is essential to abstract and summarise the structural invariables, i.e. the relationships between the parts, even though these parts may be alternatives.*[16]

This approach is also clearly echoed by two items mentioned in the competition specifications: the use of the PERT method (described by Gordon Pask as a cybernetic technique) when drawing up a precise work schedule for the nine-week project, which was divided into two work-stages: the decision-making phase and the implementation phase; and the use of a method based on a repetitive system of successive attempts to find a solution, i.e., a design process that evolves and makes progress by means of assessment and feedback.[17]

In fact, several systems interact in the IPSV. First of all, the functional system arising from a social need and an innovative teaching approach. Then (or, to be more precise, in parallel), the construction system that affects the economics of the project, i.e., design process optimisation, the ease of building the project, and cost reduction. Finally, there is the urban system, which emulates typical city life and anticipates growth and change, and features a civic centre (the 'agora'), separate roads and pedestrian walkways, and a general network of facilities. The ways in which these three systems operate and interact are examined in the following sections.

Functional system

It is not possible to understand the scope of the university reform that led to the creation of the IPSV without taking a look at how the authorities shifted the brunt of responsibility away from faculties and onto departments. It was this new organisation based on departments that made it advisable to bring the different parts of a university together on a single site.[18] The classical concept of the faculty as an isolated building was deemed obsolete once it was understood that advances in knowledge are made at the boundaries where disciplines come into contact with each other:[19]

> *The way the Polytechnic was organised originally as an amalgamation of existing schools within a set of related departments, which featured to a great extent characteristics typical of said organisation by schools, changed to a well- consolidated, new structure in which the departments assumed the leading role.*[20]

The increasing numbers of variables in the programme made it necessary to contemplate new ways of dealing with this complexity. It was no longer a matter of facilitating the appropriate relationships between a limited number of elements (four schools), but between a far greater number of entities (twenty-nine departments), whose links were also expected to change over time.

The IPSV programme is a list of relationships rather than functions. This is what the architects understood and, indeed, they did not hesitate to quantify the robustness of said relationships within the system. As a matter of fact, one of the main papers about architecture and town planning from a system approach, published by the centre for Land Use and Built Form Studies at Cambridge, UK, under the direction of Leslie Martin and Lionel March in 1972, gives some advice about this type of mathematical model:

> *The essential feature of such a model would be the establishment of a comprehensive series of mathematical relationships between the different parameters which affect the physical aspects of university planning.* [...] *Because of the mathematical nature of the model, and of the large volumes of numerical data involved, treatment by computer techniques is particularly appropriate.*[21]

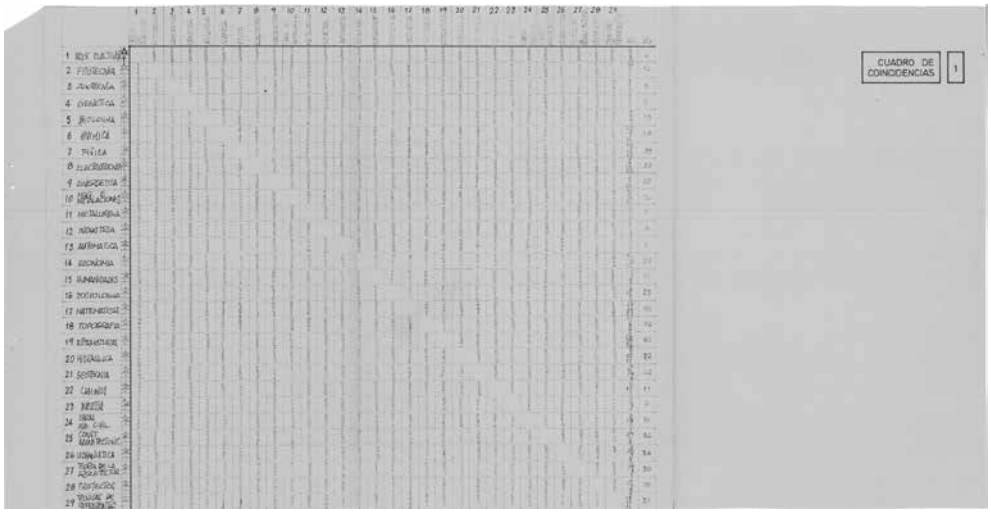
This is debatable because there can be no doubt that the choice of parameters is crucial when inferring an abstract model, in line with reality, able to give shape to organised complexity. Apart from the fact that this approach only takes into account those aspects of life in society that can be codified, the wrong choice of variables for this model intended to control complexity might ultimately circumvent the very complexity it was designed to address.[22]

In a short report dated 22 September 1972, the IPSV architects explained how they analysed the programme and drew up a zoned organisation chart for the future university. In order to keep students' walking distances to a minimum, they quantified the similarities between departments according to a new concept, the 'number of overlaps', which they defined as follows:

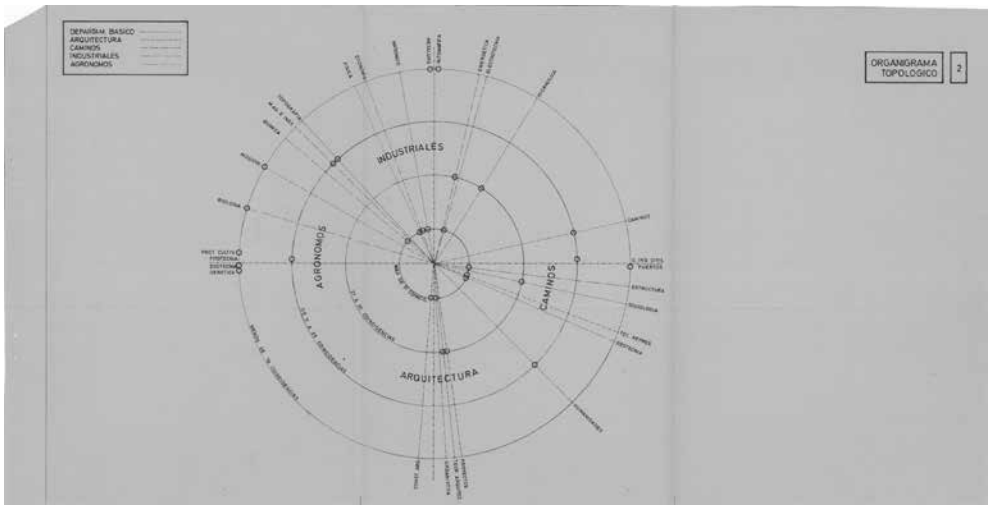
> *The number of overlaps between two departments as regards a certain degree is defined as the number of subjects in said degree taught by both departments in the same semester.*
> *'The number of overlaps between two departments as regards the university' is the number of subjects in any degree that both teach in the same semester.*[23]

Once defined, each parameter was then calculated for each department as a function of its greater or lesser similarity with the other departments, as regards each degree, and finally, as regards the university as a whole. The overlaps were then compiled in a table of twenty-nine columns and twenty-nine rows (one per department) each divided into four cells – one for each degree *[3]*. Finally, two figures were obtained for each department: the total number of overlaps as regards a given degree, which would determine the relative position of the department; and the total number of overlaps,

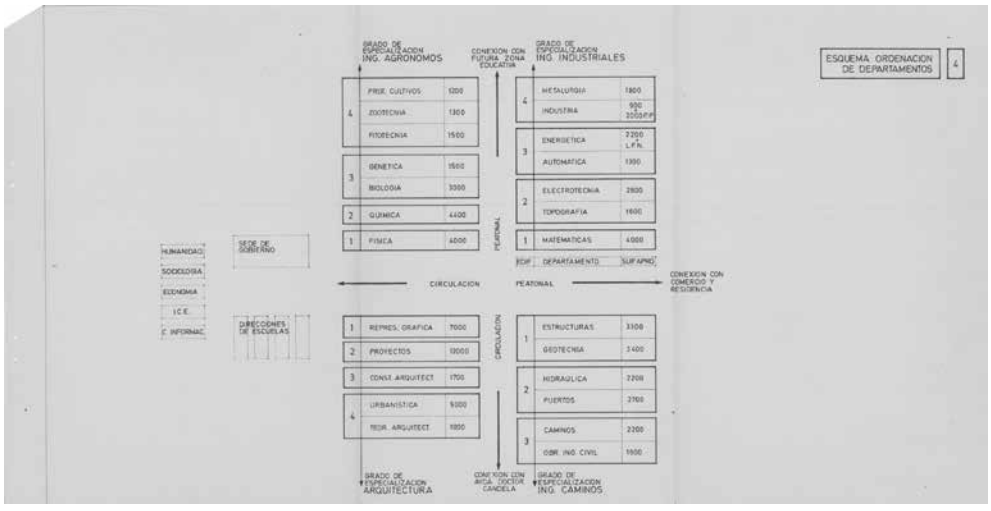
https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press



3 Table of overlaps for the IPSV's departments, 1972. Rows and columns display departments. From top to bottom and from left to right: Crop Production, Plant Breeding, Animal Science, Genetics, Biology.



4 Final topological chart for the IPSV, 1972. The legend shows a different line depending on the adscription of a department to an academic degree. From top to bottom: Basic Department, Architecture, Civil Engineering, Industrial Engineering, and Agricultural Engineering.



5 Zoned organisational chart for the IPSV's departments, 1972. Orthogonal axes are labelled as pedestrian paths, leading to connections with shopping and residence (on the right), future educational area (up), and an existing avenue (bottom). On the left the University Governance, the Schools' Deaneries, and other common services. The four quadrants contain the location of the departments associated with an academic degree.

which would determine the department's distance from the centre of the university.

The data obtained from this table of overlaps were used to draft a topological chart showing the interactions between the departments and their positions in relation to the four degrees and the centre of the university *[4]*. Each degree was assigned to one of the four axes on the chart, and the number of a department's overlaps was defined by the coordinates of a point. A straight line was then drawn between said point and the centre. The smaller the distance between this straight line and one of the axes, the greater the affinity with the given degree. On the basis of this bundle of straight lines, and after calculating the distance to the centre from a department's total number of overlaps (in bands of ten), it was possible to determine the department's exact location in the system.

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

Finally, the architects drew up a zoned organisational chart that divided the departments into four zones *[5]*. The departments with the most overlaps would be located near the centre, while more specific departments would be further out. At this stage, however, the logic of the process seems contradictory because if the intention was to relegate schools to the background and merge them into a system of interwoven departments, why was the school as an entity subsequently reconstructed? In addition, the zoned organisation chart features a certain hierarchy which, despite helping to clarify the chart as a whole, nonetheless conditions and even inhibits other unforeseeable relationships. A university conceived of as a system of interrelated departments cannot be endowed with a hierarchical structure without jeopardising its ability to operate as a network. Furthermore, by definition, there can be no hierarchy in a system that enables more than one type of relationship between its elements.[24]

This way of organising the IPSV could also be said to be rather mechanical, as if the architects had discarded the intuition usually applied when situating and linking the different parts of a programme. But there can be no doubt that this decision is also underpinned by the actual scope of the project: the daily movements of twelve thousand people across a campus occupying some 100,000m2 could not be dealt with by merely an intuitive sense of what was needed – hence this quantification of the solution, the outcome of a systematic (and, it must be said, rather dispassionate) approach to the problem.

However, there is also a sort of hiatus between the mathematical procedure (computerised or otherwise) and the formal expression that betrays and also justifies the architect. Although it is true, in the light of their calculations, that the IPSV architects could have entrusted part of their 'design' to a computer, it is equally true that computers, as M. E. Drummond said in 1960, 'have no aesthetic sense whatsoever. Furthermore, they have no imagination'.[25]

Construction system

As of the tender phase, the IPSV architects viewed the materialisation of the project as an exercise in combining prefabricated concrete parts.[26] Prefabrication was mainly chosen not only because it obviously simplified the production process, but also because of its impact on the creative process, i.e., it helped standardise the design phase.[27]

The prefabricated project was apparently divided into two successive periods: firstly, the project of the project (the meta-project) or the 'theoretical, critical and organisational moment', and then the project itself, i.e., 'the moment when the specific formulation of each particular building is created':[28]

> *Whereas the project (in its traditional sense) is a* direct *act of design materialised in different forms by applying the parameters of a style, meta-project is an* indirect *act of design* [...] *created as a structure to be reproduced and suitable for possible unique projects in the future, which involves largely interdisciplinary parameters.*[29]

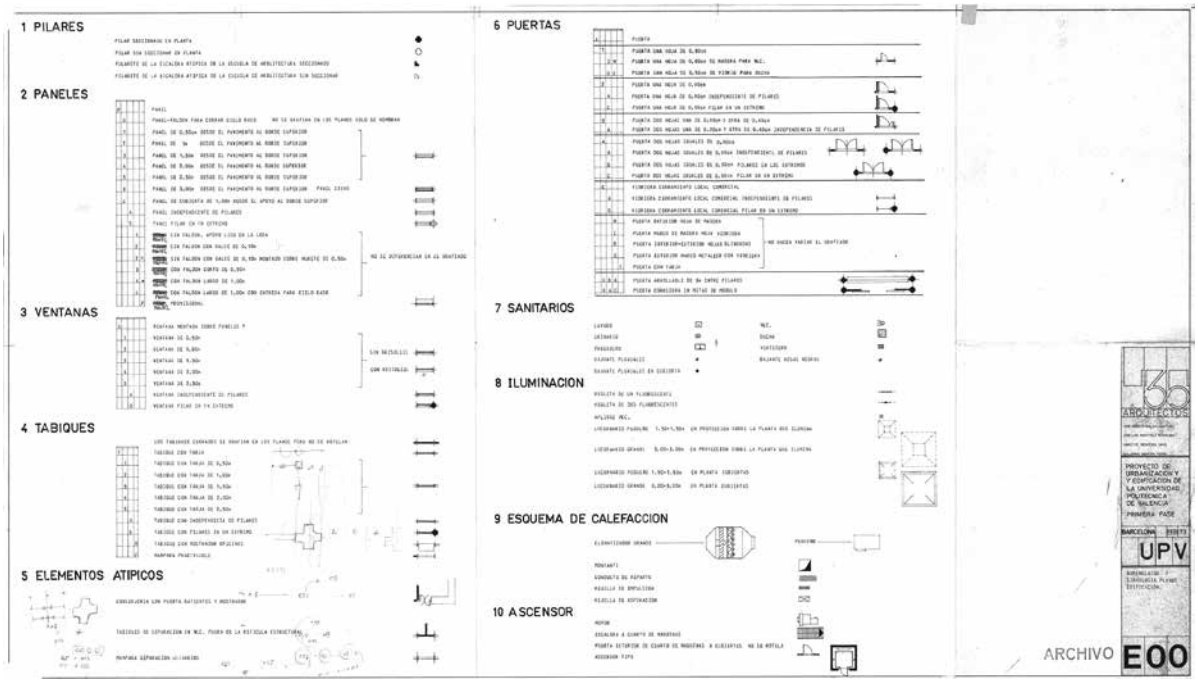
Logically enough, Christopher Alexander considered prefabricated construction systems to be the paradigm of his 'system generator' concept because they consisted of a set of elements to be fitted together according to certain rules.[30] It was precisely the obvious need for rules to coordinate all the parts in prefabrication systems that made some architects choose them – with the necessary precautions. The debate about a supposed lack of creativity is reflected in the papers and handbooks about prefabricated construction, particularly the popular study published by the engineer José Antonio Fernández Ordóñez (in conjunction with the think tank known as the Seminario de Prefabricación), *Prefabricación: teoría y práctica* (Prefabrication: theory and practice).[31] Other useful contributions were made by Rafael Leoz de la Fuente who, in response to the debate about the supposedly limited creativity of prefabricated construction, declared, 'Don Quixote was written with the twenty-nine letters of the Spanish alphabet.'[32]Alfonso del Águila was even more graphic when he commented some time later that the rules governing prefabricated construction made '[the architect's work] more thorough, more unfettered'.[33]

Spanish architects were then indebted to the international trends in favour of prefabricated construction. In the Anglo-Saxon context, the crucial writings by Bruce Martin, *The Co-ordination of Dimensions for Building*, and *Standards and Building*, were published precisely during this period of time.[34] Martin addressed the theoretical and practical implications of standardisation in building, and noticed how they 'affect both the design methods in the office and the constructional methods on site'.[35] Also the role of the Modular Building Standards Association in the US and the Modular Society in the UK was important. Their function was none other than 'the promotion of research, experiment, development and discussion, and collecting and disseminating information concerning a module and related dimensions in the design and construction of buildings'.[36]

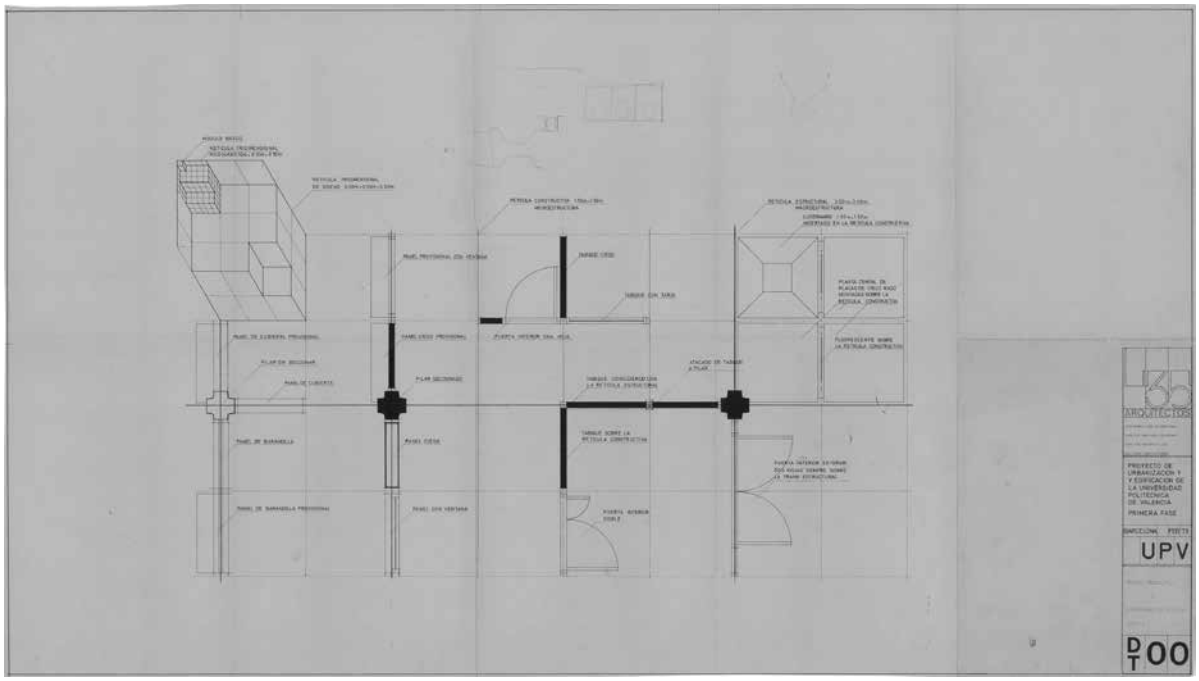
One of the basic tools in the prefabricated project was the module, already present in the proposal submitted for the IPSV competition. At that stage, it still consisted of two orthogonal series based on the 2.5m industrial module. The 1.25m and 0.83m sub-modules dictated the dimension of the most common construction elements, while multiples of 2.50m, 5.00m and 7.50m dictated the structural design.[37] The module finally used in the design phase measured 3.0m, probably to bring the metrics of the new construction into line with the *Pretécnico* – designed by the architects Joaquín Hernández Martínez and Carlos Prat Cambronero to house the IPSV temporarily – inaugurated in the summer of 1970.[38]

The drawings in the IPSV production information may be classified, according to the terminology used by Caporioni, Garlatti, and Tenca-Montini, as: (1) drawings of the components; (2) drawings of joins in detail; (3) drawings for joining up the project.[39] Some of these drawings are not very useful for the construction process but are nonetheless particularly

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press



6



7

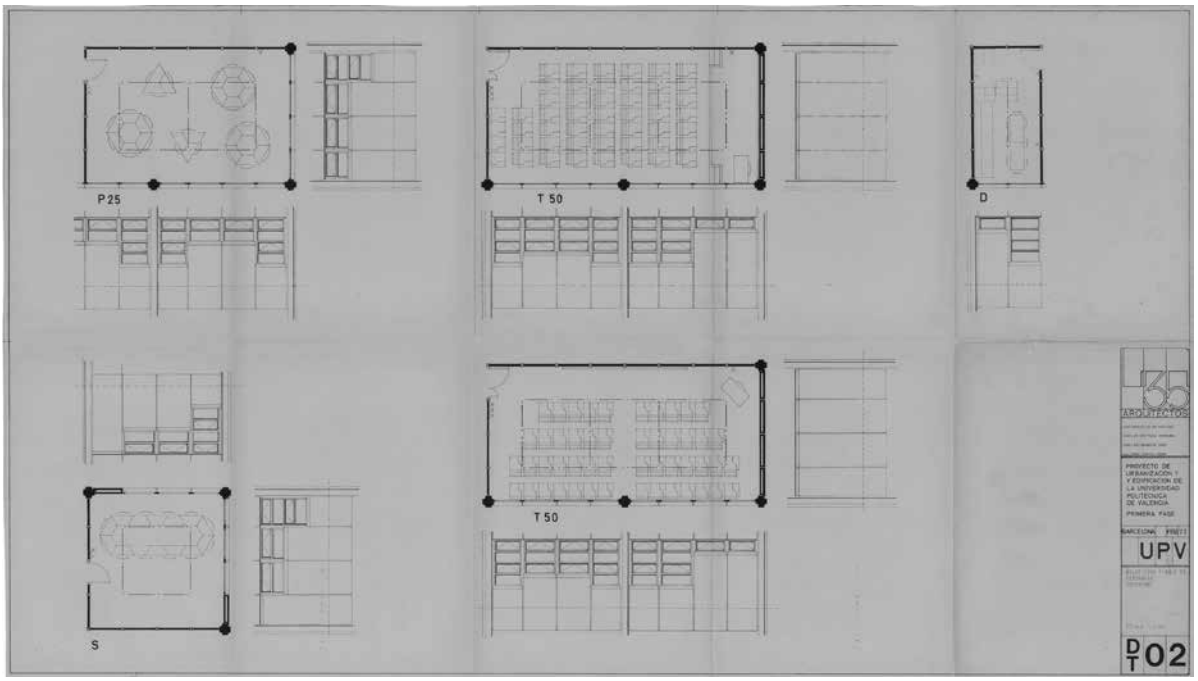
important because, in all likelihood, they were drafted to explain the nature of the project.

The first such drawing (plan E-00) entitled 'Nomenclature and symbols [on] construction plans' lists the symbols found on the different drawings in the project, although its main purpose was to catalogue the elements in the system, including the atypical elements intended to remedy contingencies *[6]*.

Plan DT-00, 'Modular grids and module layout', shows how these elements are to be arranged on the 1.5m modular grid and is a veritable manifesto that champions the advantages of not only the basic module and the structural grid but also the metric discipline of the wall panels, partitions,[40] indoor and outdoor carpentry, bannisters, skylights, and even the fluorescent tubes for indoor lighting *[7]*. This document demonstrates the architects' in-depth knowledge of a design method that embraces not only the analysis of the requirements programme but also the standardisation of the construction elements – the internal logic of which is quite exemplary.

The series of DT plans contains the list of typological elements that constitute the link between the construction elements and the building *[8]*. These drawings demonstrate the appropriateness of the construction system for creating certain spaces with specific functions, arising from the painstaking analysis of the departmental programme. Also featured in the competition drawings are the classrooms, lecture

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press



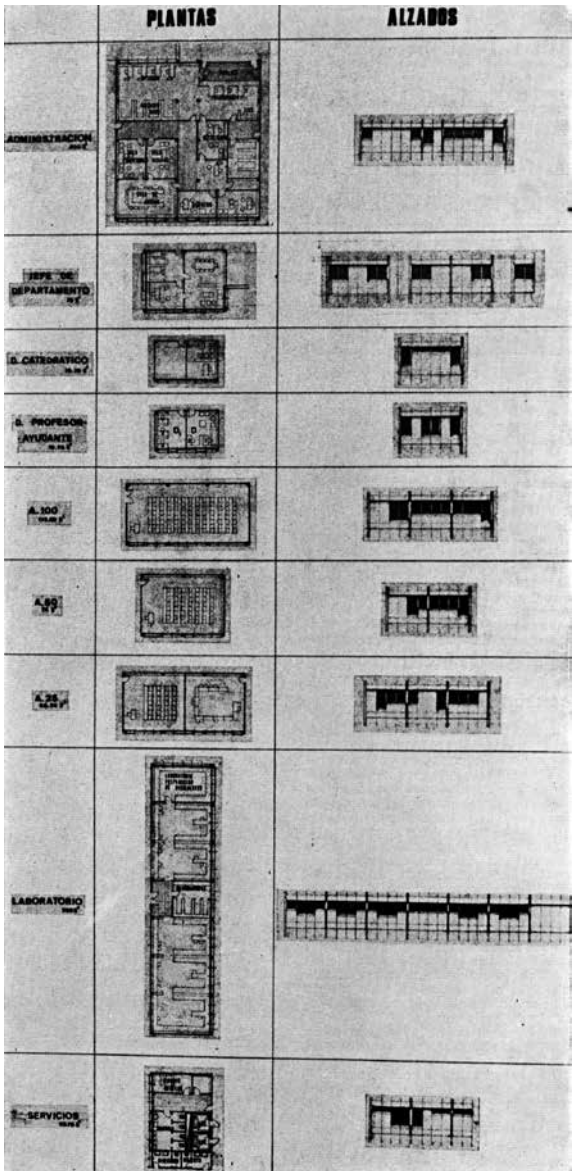
8

6 'Nomenclature and symbols [on] construction plans' (plan E00), 1973. Groups of elements: 1. Pillars; 2. Panels; 3. Windows; 4. Partitions; 5. Atypical elements; 6. Doors; 7. Sanitation; 8. Lighting; 9. Heating scheme; 10. Lift.

7 'Modular grids and module layout' (plan DT00), 1973. Legends on the top define the different grids. From right to left: Basic module; Three-dimensional modular grid 0.10m x 0.10m x 1.10 m; Three-dimensional design grid 0.50m x 0.50m x 0.50m; Building grid 1.50m x 1.50m. Micro-structure; Structural grid 3.00m x 3.00. macro-structure.

8 Typical lecture rooms, seminar rooms and offices (plan DT02), 1973.

9 Typological elements of the competition entry for the IPSV, 1970.



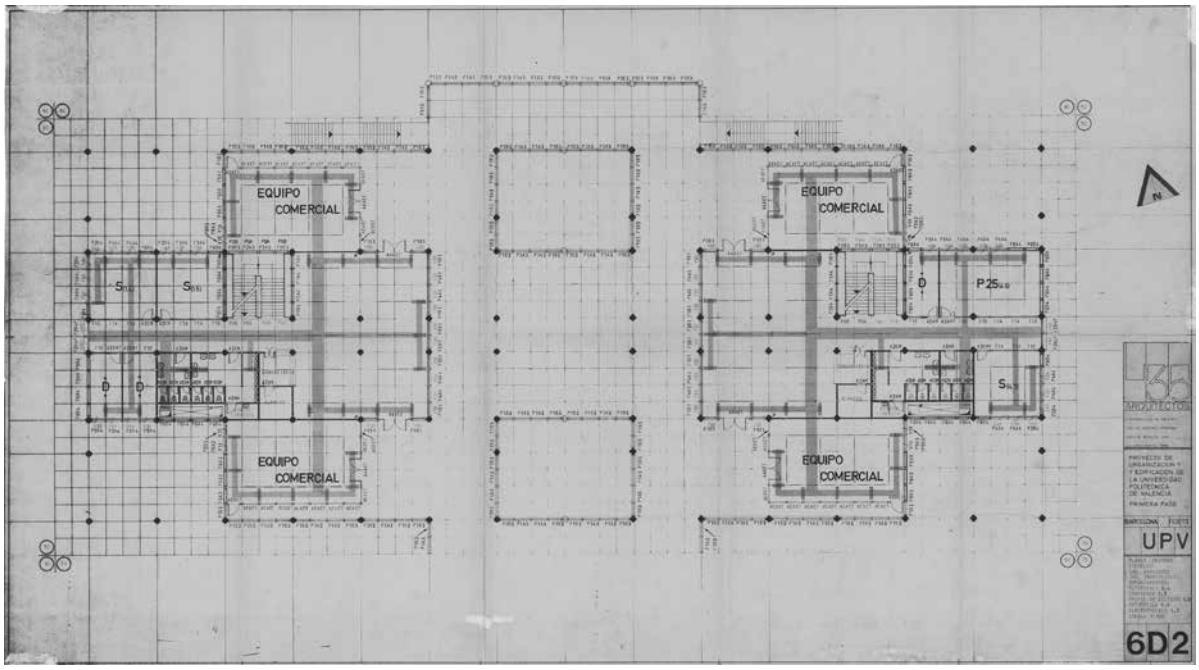
9

theatres, offices, laboratories, toilets, and service and communication cores that constitute this other catalogue of parts ready to be grouped together and combined during the 'assembly' work-stage of the building *[9]*.

The next phase in this theoretical assembly work-stage involves the sections (33m x 36m), which are to join together like links in a chain to form the departments *[10]*. Their internal organisation is governed by two gradients – one horizontal and one vertical – which dictate the location of different uses. Horizontally: at one end, the access from the pedestrian precinct and the admin offices; and at the other end, the connection to the research laboratories. Vertically: on the ground floor, the heavy laboratories; and on the upper floors, the main walkways and actual teaching areas. These sectors appear on another series of plans with names that refer unequivocally to the general ground plan.

Once again, the design process in this instance apparently calls not so much upon the architects' creative capacity as their ability to comply with a set of well-defined rules. Although it is true in the IPSV that no effort was made to transform the programme data or construction processes into a

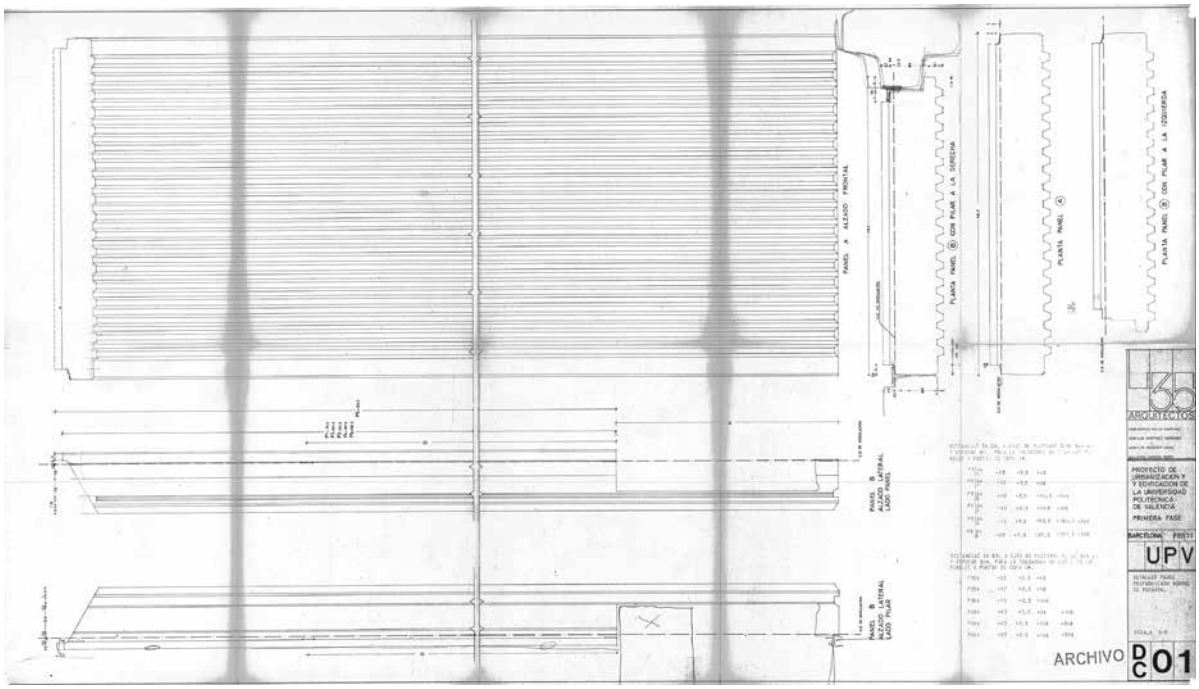
https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press



10



11



12

10 First floor plan of the 6D-sector (plan 6D2), 1973.

11 View of the building site, c. 1973.

12 Striated wall panel's details (plan DC01), 1973.

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

meaningful form, it is also true that with such a well-defined and appropriate strategy, other form-giving mechanisms were in no way needed.

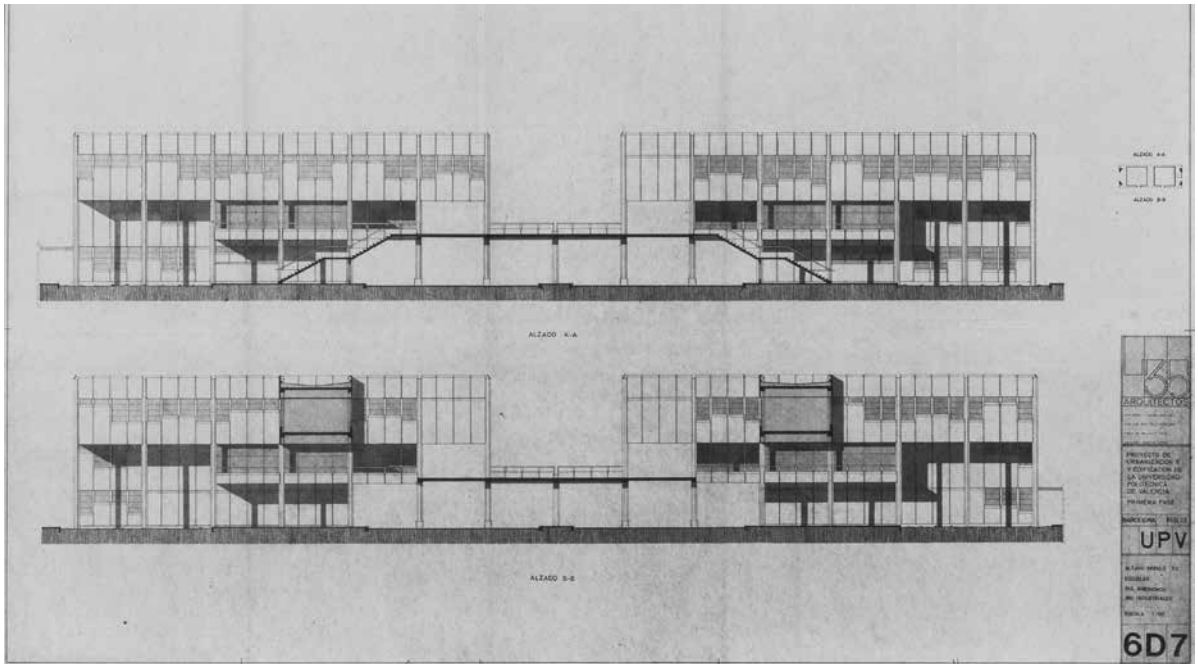
The architects do, however, make certain concessions to appearance. Their concern about a predictable monotony, for example, led them to combine a variety of wall panels with openings and solid sections of different sizes, which also increased the coherence between the outer appearance and the specific use of the interior areas *[11]*.[41] But it is possibly at the junctions between the striated wall panels and the characteristic cruciform columns that a concern about form manifests itself more obviously *[12]*. Although the outlines of both elements are rather classical in style, the fact that a panel in contact with a cruciform column should, in any case, be an exception to the rule, reveals that the underlying logic of these plans is not merely technical but, above all, a form of aesthetic expression whose ultimate aim is to retain the attributes of order and ensure that the walls are joined together by a connection system in keeping with the requirements of the module.[42] The standardised construction system underpins this subtle creation of form just as grammar underpins language.

Urban system

One of the original aims of the IPSV project was to reconcile its strictly academic uses with social and cultural activities:

> *Its organisation must, on the one hand, meet its specific nature by means of a specific, operative academic structure, and must, on the other, not only allow but foster social interaction by means of an appropriate civic and cultural structure.*[43]

The project submitted in the competition was already 'a functional whole, which did not detach academic activities from urban life'.[44] In other words, the architects understood from the outset that the



13

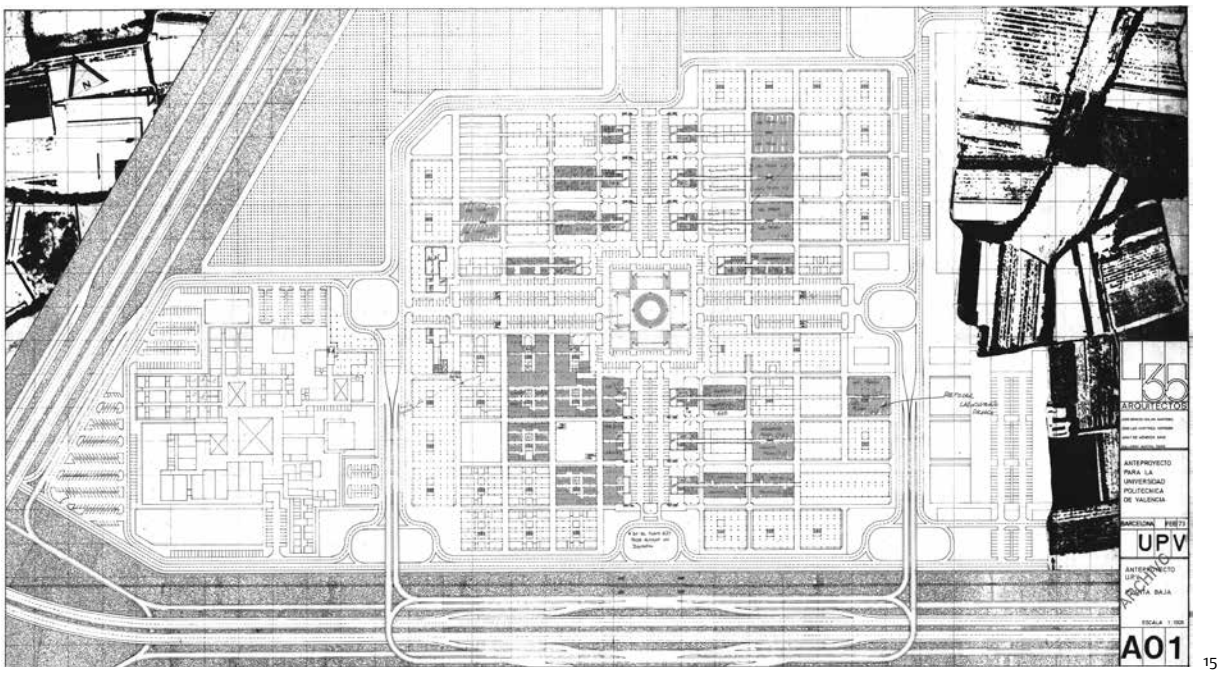


14

13 Elevation of the 6D-sector (plan 6D7), 1973.

14 View of the agora, c. 1974.

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press



15

15 Ground floor plan of the IPSV (plan A01), 1973.

future university had to have certain properties traditionally associated with cities. Reyner Banham made an interesting comment in this respect. He was of the belief that 'university mega structures' were responsible for implementing certain urban models which had had little impact on actual cities.[45] One very representative example was the creation of separate routes for pedestrians and vehicles on different levels. Theoretical proposals such as the one by Alison and Peter Smithson for the Berlin Hauptstadt (1957) were echoed in quite a few universities in later decades. Noteworthy examples in Spain were the project by Antonio Fernández Alba for the Universidad Autónoma de Madrid (1969) and, to a lesser extent, the project by L35 Arquitectos for the IPSV.

This distribution of circulation on different levels did not feature in the drawings for the IPSV competition, but was one of the main changes made at the project phase. The solution adopted consisted of a raised pedestrian walkway at first-floor height. This determined the real level of interaction and relegated vehicular traffic and parking areas to the ground level *[13]*. Countless patios, staircases, and ramps between the two levels provided the lower floor with minimum living conditions plus certain strategic connections. The main connection was the geometric and symbolic hub of the university: the agora with its patently urban vocation, that somehow represented the coming together of all the parts in the structure in pursuit of common goal *[14]*. From this privileged observatory the university emerges as 'a veritable city with all its dynamic characteristics of the exchange and communication of information, services, and products'.[46]

The university-city simile began to endow the university with the properties of a system operating like an organic whole: 'If we view the urban reality as a system, we must simultaneously define its parts and their relationships', said the IPSV architects.[47]

The difficulty is, once again, the choice of variables, i.e., the attributes of the traditional city which are to be reproduced in the university complex. The interplay of problems related to traffic, accommodation, teaching, commerce, and leisure activities requires a systems approach. As called for by Leslie Martin and Lionel March, 'the spatial structure of a city is a system [...]: that is the complex pattern of constantly changing interactions which determine and are in turn determined by the spatial structure of a city'.[48]

Indeed, a city is more able to guarantee growth and change than an individual building. This is why this essential requirement is necessarily underpinned by an identity (i.e., the university as a city), as is patently clear in the general ground plans of the IPSV, which show the basic principles governing the application of the method *[15]*. In short, this redefinition of the architectural project is, in fact, an indication of the concerns of an entire period:

> *Hence the project is understood to be a functional, constructive, typological and urban system that can be changed and used for different purposes, and also as a process enabling such transformations by means of channels not at odds with each other.*[49]

It is at this stage that the project attains a greater degree of synthesis. It is the urban system that translates the complex functional relationships found in the programme into specific spatial relationships. Firstly, the location of the departments accessed from a pedestrian precinct, facilitates connections at one end while enabling expansion at the other end; and secondly, the same pedestrian walkway embodies a backdrop for the interaction envisaged in the functional diagram. In short, the value of a work of architecture is never limited to its own layout.

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

Conclusion

The conclusion to the foregoing can be expressed by a series of analogies. First of all, the functional system would symbolise the substance that breathes life into the university as an organism. Not for nothing are the internal relations between the different parts of the university programme (i.e., its departments), which define its overall behaviour as a complex organisation. Thus the university project falls into line with its social and political context, reconciling itself with the prevailing mass culture and a more democratic form of education accessible to a broader spectrum of society.

Secondly, the construction system is like the genetic code that determines its development possibilities from the outset. Indeed, the standardisation of the production process affects the logic of the creative process and divides it into two successive stages: meta-project and specific formalisation. In the IPSV, the inherent rules of the construction system impose certain limits on creativity without inhibiting the formal imagination of architects.

Finally, the urban system would be the shape that such an organisation would have in space. The application of certain urban models to the architecture of the university facilitates the coexistence of urban life and academia, despite the inner workings of the new (university) city being hampered by its isolation on the outskirts of the actual city. The IPSV and the Free University of Berlin are, in fact, both closed systems and yet they are a constant reminder of the extent to which the application of systems theory to university planning during the 1960s and early 1970s was to provide a new concept of the functional, material and social prerogatives that contribute to knowledge sharing, the economics of construction, and a well-balanced life in a community.

Notes

1. For an analysis of the meaning of *programme* in modern architecture, see: John Summerson, 'The Case for a Theory of Modern Architecture', in *Architecture Culture 1943–1968: A Documentary Anthology*, ed. by Joan Ockman (New York: Rizzoli, 1993), pp. 227–36 (published originally in the *RIBA Journal*, 6 (1957), 307–10); See also Anthony Vidler, 'Toward a Theory of the Architectural Program', *October,* 106 (2003), 59–74.
2. Andrew Rabeneck, 'Whatever Happened to the Systems Approach?', *Architectural Design,* 5 (1976), 298–303.
3. For an argument in favour of complexity and a systems approach, see: Royston Landau, 'Complexity and Complexing', *Architectural Design*, 10 (1972), 608–10; Josep Maria Montaner, *Sistemas arquitectónicos contemporáneos* (Barcelona: Gustavo Gili, 2008), p. 11, the relevant section translates as: 'Hence, I understand a system to be a set of heterogeneous elements, physical or otherwise, on different scales, which are related to each other and are organised internally in a strategic attempt to adapt to the complexity of the context and which constitutes a whole that cannot be explained by merely the sum of its parts' (our translation).
4. Ludwig von Bertalanffy, *General System Theory: Foundations, Development, Applications* (New York: Braziller, 1968), p. vii.
5. For the application of the fundamentals of cybernetics to architecture, see: Gordon Pask, 'The Architectural Relevance of Cybernetics', *Architectural Design*, 9 (1969), 494–6; Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine* (Paris; Cambridge, MA: Hermann and Cie, 1948).
6. Shadrach Woods, 'Web', *Le Carré Bleu*, 3 (1962), 3.
7. Christopher Alexander, 'Systems Generating Systems', *Architectural Design*, 12 (1968), 610.
8. Sean Wellesley-Miller, 'Self-Organizing Environments', *Architectural Design*, 5 (1972), 316. For the relationship between these ideas and Umberto Eco's *opera aperta* concept, see: Débora Domingo Calabuig and Raúl Castellanos Gómez, 'Obra Abierta: del pensamiento al proyecto [The Open Work: From the Concept to the Project]', *Palimpsesto,* 7 (2013), 10.
9. Von Bertalanffy, *General System Theory*, p. xiii.
10. Alison Smithson, 'How to Recognise and Read Mat-Building: Mainstream Architecture as it has Developed Towards the Mat-Building', *Architectural Design*, 9 (1974), 573–90 (573). This was a retrospective article for the author admitted that some of her theories had already appeared in the 'Team 10 Primer' published in *Architectural Design*, 12 (1962), 559–601.
11. *La educación en España: Bases para una Política Educativa* [Education in Spain: Bases for an Education Policy](Madrid: Ministerio de Educación y Ciencia, 1969).
12. For details of the competitions for autonomous universities, see: Raúl Castellanos Gómez and Débora Domingo Calabuig, *'1969: las universidades españolas a concurso. Bases, resultados y polémicas* [1969: Tenders for Spanish Universities: Conditions, Results and Controversies]', *PPA: Proyecto, Progreso y Arquitectura*, 7 (2012), 90–103.
13. The whereabouts of the original documents of the winning proposal are unknown, although they were published in considerable detail in 'Concurso de anteproyectos para el Instituto Politécnico Superior de Valencia [Scheme design competition for the Instituto Politécnico Superior de Valencia]', *Cuadernos de arquitectura*, 76–7 (1970), 117–20. The team consisted of the architects José Ignacio Galán Martínez, José Luis Martínez Honrubia, Juan Fernando de Mendoza Sans, and Guillermo Murtra Ferré, in conjunction with Gonzalo García Muñoz and Ignacio Paricio Ansuategui. Javier Carvajal Ferrer won second prize in the competition (General Archive, University of Navarre). There were also five runners-up including Javier Seguí de la Riva whose project was published in *Arquitectura*, 161 (1972), 50. The full results of the competition, which was held on 29 May 1970, can be seen in the *BOE* (Spain's official gazette), 143 (16 June 1970), p. 9445; and news of the competition appeared in the Spanish daily *ABC* (31 May 1970), p. 29.
14. L35 Arquitectos, *Anteproyecto para la Universidad Politécnica de Valencia: memoria A00* [Scheme design for the Universidad Politécnica de Valencia: document A00],

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

Barcelona, November 1972, p. 4. Underlined in the original.
15. Ibid., p. 5.
16. Ibid., p. 6, our translation.
17. Pask, 'The Architectural Relevance of Cybernetics', p. 494; '*Concurso de anteproyectos para el Instituto Politécnico Superior de Valencia* [Scheme design competition for the Instituto Politécnico Superior de Valencia]', 117–18. The suitability of an evolutionary design process for dealing with large-scale, highly complex problems is championed in Jaymes R. Boyce, 'What is the Systems Approach?', in *Rethinking Technology: A Reader in Architectural Theory*, ed. by William Braham and Jonathan A. Hale (London: Routledge, 2007), pp. 172–7 (first published in *Progressive Architecture*, 11 (1969), 118–21).
18. In this structure, teaching is now the responsibility of the department: an institution between the faculty and the teaching staff, i.e., a basic instrument of coordination. In Spain, the department was created by the Structures Law of 1965, although the White Paper of 1969 was an indication that it had not yet been fully configured. The IPSV was to be organised into twenty-nine departments during the reorganisation carried out in March 1971 (the year that it became a university). These departments covered four areas: architecture, industrial engineering, civil engineering, and agronomy.
19. Carles Muro and Ton Salvadó, *Freie Universität, Berlín: una organización construida. Candilis, Josic, Woods & Schiedhelm* [Freie Universität, Berlin: a built organisation. Candilis, Josic, Woods & Schiedhelm] (Madrid: Colegio de Arquitectos de Madrid, 2001), p. 15.
20. L35 Arquitectos, *Memoria A00*, p. 3, our translation.
21. Nicholas Bullock, Peter Dickens and Philip Steadman, 'A Theoretical Basis for University Planning', in *Urban Space and Structures*, ed. by Leslie Martin and Lionel March (London: Cambridge University Press, 1972), pp. 113–14.
22. Christopher Alexander, 'A Much Asked Question About Computers and Design', in *Architecture and the Computer: Proceedings of the First Boston Architectural Center Conference* (Boston: MIT, 1964), pp. 52–6.
23. L35 Arquitectos, *Anteproyecto para la Universidad Politécnica de Valencia: memoria C00* [Scheme design for the Universidad Politécnica de Valencia: document C00], Barcelona, 22 September 1972, p. 2, our translation.
24. Ronald Levy, 'General Systems Theory: A Brief Commentary', *The Journal of Creative Behavior*, 3 (1979), 190. A linear infrastructure such as those put forward by Carvajal and Seguí for the IPSV competition would be a different case.
25. M. E. Drummond, 'Computers', in Reyner Banham (ed.), 'The science side: weapons systems, computers, human sciences', *The Architectural Review*, 757 (1960), 188.
26. The state of the Spanish economy in the wake of the oil crisis of 1973 made it advisable to incorporate certain onsite techniques, such as pouring concrete columns and beams. The architects José Ignacio Galán Martínez and José Luis Martínez Honrubia admitted this to the authors of this article during an interview conducted in Barcelona on 30 January 2012.
27. Alfonso del Águila García, 'Industrialización, arquitectura y arquitectos [Industrialisation, Architecture and Architects]', *Arquitectura*, 174 (1973), 20.
28. G. Mario Oliveri, *Prefabricación o metaproyecto constructivo* [Prefabrication or Construction Metaproject) (Barcelona: Gustavo Gili, 1972), p. 174.
29. Ibid.
30. Alexander, 'Systems Generating Systems', 610.
31. Ramón Arandes Renu et al. (eds), *Prefabricación: teoría y práctica* [Prefabrication: Theory and Practice], 2 volumes (Barcelona: Editores Técnicos Asociados, 1974). Their conceptual approach was published previously in a small volume: José A. Fernández Ordoñez and Seminario de Prefabricación (eds.), *Arquitectura y represión* [*Architecture and Repression*] (Madrid: Cuadernos para el diálogo, 1973). The Seminario de Prefabricación was developed by Fernández Ordóñez at the Madrid School of Civil Engineers from 1967 onwards. The IPSV architects highlight the importance of the studies by Fernández Ordóñez in the interview mentioned above (see fn. 26).
32. Interview with the Seminario de Prefabricación published in 'Conversación con Rafael Leoz de la Fuente [Conversation with Rafael Leoz de la Fuente]' in *Arquitectura y represión*, p. 209.
33. Alfonso del Águila García, *La industrialización abierta y su situación en Europa* [Open Industrialisation and its situation in Europe] (Madrid: Colegio Oficial de Arquitectos de Madrid, Comisión de Asuntos Tecnológicos, 1980).
34. Bruce Martin, *The Co-ordination of Dimensions for Building* (London: Royal Institute of British Architects, 1965); *Standards and Building* (London: Royal Institute of British Architects, 1971). Subsequently, the book by Martin, *Joints in Buildings* (London: Godwin, 1977) was translated and published in Spain: *Las juntas en los edificios* (Barcelona: Gustavo Gili, 1981).
35. Martin, *Standards and Building*, p. 92.
36. Ibid., p. 69. The Modular Society began to publish transactions in *The Modular Quarterly* in 1955.
37. 'Concurso de anteproyectos para el Instituto Politécnico Superior de Valencia' [Scheme design competition for the Instituto Politécnico Superior de Valencia], p. 119.
38. For a schematic ground plan and the perspective of the 'Pretécnico', see: Joaquín Hernández Martínez and Carlos Prat Cambronero, 'Proyecto para Instituto Politécnico Superior' [Design for the Instituto Politécnico Superior], *Cuadernos de arquitectura*, 78:2 (1970), 102.
39. The drawings consulted are housed in the professional archives of the architectural firm L35 Arquitectos in Barcelona, and in the Infrastructure Department archives at the Universidad Politécnica de Valencia; Vittorio Caporioni, Garlatti and Tenca-Montini, *La construcción modular* [Modular Coordination] (Barcelona: Gustavo Gili, 1971), p. 197.
40. The partitions were to be made of lightweight concrete and the metal connections were to be hidden by wooden moulding that would create the modular grid visually inside the buildings. See, for example, drawing DC-13 'Details, partition upright'.
41. The architects state in their competition document that the prefabricated concrete wall panels 'endow the facades with a play of light and shadows that eliminates the possible monotony that a standardised system might cause'. '*Concurso de anteproyectos para el Instituto Politécnico Superior de Valencia*' [Scheme design competition for the Instituto Politécnico Superior de Valencia], p. 120.
42. A comparison of the construction

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

solutions on drawings DC01 and DC04 is very eloquent in this respect. The cruciform column in drawing DC01 remains visible (the panel in contact with the column is narrower than the usual panels), while the singular panel in the second drawing covers and hides the column completely, and apparently complies with a standard metrics schema.

43. Ibid., p. 119, our translation.
44. Ibid., p. 120.
45. Reyner Banham, *Megastructure: Urban Futures of the Recent Past* (London: Thames and Hudson, 1976), p. 131.
46. L35 Arquitectos, *Memoria A00* [Report A00], p. 13, our translation. The underground network of facilities housed in a corridor that could be walked through and inspected echoed this overhead fabric of circulation and movements.
47. Ibid., p. 12.
48. Leslie Martin and Lionel March, *Urban Space and Structures*, p. 159, Introduction to Part 3, 'Urban Systems'.
49. L35 Arquitectos, *Memoria A00* [Report A00], p. 11, our translation.

Acknowledgements
The authors thank José Ignacio Galán Martínez and José Luis Martínez Honrubia of L35 Arquitectos for their gentle collaboration and financial support; Ángel Martínez Sancho and José Fabuel Darocha of the Infrastructures Services at the Vice-rectorate for Campus and Infrastructure, Universitat Politècnica de València; the staff at the School of Architecture Library and Archive of the Universitat Politècnica de València, and the General Archive of the Universidad de Navarra.

Illustration credits
arq gratefully acknowledges:
L35 Arquitectos Archive, 1, 2, 9, 12, 15.
Infrastructures Services Archive at the Vice-rectorate for Campus and Infrastructure, Universitat Politècnica de València, 3–8, 10, 13.
School of Architecture Archive, Universitat Politècnica de València, 11, 14.

Authors' biographies
Raúl Castellanos Gómez is an architect with a PhD (2008) and Associate Professor at the School of Architecture of the Universitat Politècnica de València (Spain). He has published the book *Plan Poché*, granted the FAD Award for Thought and Criticism (2013). He has recently developed research on the mat-building in collaboration with Dr Domingo Calabuig.

Débora Domingo Calabuig is an architect with a PhD (2005) and Associate Professor at the School of Architecture of the Universitat Politècnica de València (Spain). She is the Editor-in-Chief of the *VLC arquitectura Research Journal*. Her current research is about the social consideration in architecture and urban design during the 1960s and 1970s.

Authors' address
Raúl Castellanos Gómez
raucasgo@pra.upv.es

Débora Domingo Calabuig
dedoca@pra.upv.es

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press

CAMBRIDGE JOURNALS

Urban History

Editors
Shane Ewen, *Leeds Metropolitan University, UK*
Simon Gunn, *University of Leicester, UK*
Rosemary Sweet, *University of Leicester, UK*
North American Editor
Robert D. Lewis, *University of Toronto, Canada*
Multimedia Editor
Philip J. Ethington, *University of Southern California, USA*



Urban History occupies a central place in historical scholarship, with an outstanding record of interdisciplinary contributions, and a broad-based and distinguished panel of referees and international advisors. Each issue features wide-ranging research articles covering social, economic, political and cultural aspects of the history of towns and Cities. *Urban History* is leading the way in academic publishing with its multimedia companions. The companions are refereed and fully linked and provide real depth to research. Online subscribers also gain access to *Urban History's* comprehensive online bibliography, which contains 34,000 searchable items including books, articles and edited collections.

Urban History
is available online at:
http://journals.cambridge.org/uhy

To subscribe contact Customer Services

Americas:
Phone +1 (845) 353 7500
Fax +1 (845) 353 4141
Email
subscriptions_newyork@cambridge.org

Rest of world:
Phone +44 (0)1223 326070
Fax +44 (0)1223 325150
Email journals@cambridge.org

Free email alerts
Keep up-to-date with new material – sign up at
journals.cambridge.org/register

For free online content visit:
http://journals.cambridge.org/uhy

CAMBRIDGE UNIVERSITY PRESS

https://doi.org/10.1017/S1359135517000045 Published online by Cambridge University Press