Diagrammatic Drawing for Sequencing across Disciplines and Pathways

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Abstract

This paper frames curriculum redesign as a practice of diagrammatic drawing in which shared representations operate as synaptic surfaces: operational interfaces used to connect disciplines, impose temporal sequencing constraints, and make pathways legible. In a Sino-Italian joint bachelor's program (delivered entirely in China with a mixed Chinese-Italian faculty), the initial issues were identified based on a synthesis provided by the partner institution of recurring student feedback, along with consultations with teaching staff. A multidisciplinary working group iteratively co-designed alternatives on a shared diagrammatic surface, formalizing successive versions in a verifiable mapping file. Syllabus analysis supported a two-level model: mutually exclusive Disciplines (used for conservative quantitative checks via delivered contact hours) and non-exclusive Pathways (used to articulate and describe transdisciplinary trajectories). The representation-track case study shows how the process makes the progression across methods and techniques of representation explicit and negotiable. The paper reports structural evidence and decision traceability only, deliberately excluding claims about potential employability outcomes for students.

Keywords: diagrammatic representation; schematic artifacts; learning pathways; design visualization; synaptic surfaces.

Introduction

Curriculum redesign is often treated as an administrative exercise: courses are listed, moved, merged, or renamed, while the relationships that structure a program –dependencies, sequencing logics, and pathway trajectories– remain implicit. As a result, the curriculum's underlying rationale can be difficult to grasp for those who must work within it: students, instructors, and program coordinators. In this paper, redesign is instead approached as a problem of diagrammatic drawing. Shared representations are understood as synaptic surfaces: operational interfaces in which connections can be made visible, questioned, and reconfigured. This perspective aligns with the argument that tabular maps tend to flatten curricular relationships and that more explicit representational models are needed to externalize connections and change [Willcox, Huang 2017, p. 3].
The contribution extends beyond the analysis of learning outcomes, positioning itself as an account of how combined diagrammatic and tabular artifacts support collective reasoning in a complex transnational setting. Building on a tradition that understands schematic artifacts as projective devices within design culture [Anceschi 1988; Munari 1993], we present a process in which graphic representation is used to negotiate temporal sequencing and disciplinary interfaces, and to communicate transdisciplinary pathways as intelligible

trajectories. The case study focused on the representation strand anchors this argument within the disciplinary field of drawing, showing how the progression across tools and methods of representation can be articulated and discussed through shared diagrams.
The contribution addresses two questions: What representational properties make shared diagrams 'synaptic surfaces' that are operational for collective curriculum decision-making? How does a two-level model (Disciplines and Pathways) enable conservative structural checks while preserving transdisciplinary trajectories as communicable sequences?

Diagrammatic drawing as a synaptic surface

Diagrammatic drawing occupies an epistemically distinctive space within design culture: it is not a neutral depiction of the world, but a device through which thinking is externalized, organized, and made negotiable [Larkin, Simon 1987, p. 65] and, more broadly, the mark does not simply transcribe an already formed idea; it generates a field of interpretations and successive transformations that guide design reasoning [Goldschmidt 1991, p. 123]. Within the tradition of drawing, schematic artifacts have been understood as projective devices that do not reproduce reality but anticipate and structure it [Anceschi 1988; Munari 1993], extending into a domain in which representation supports cycles of decision-making and reframing typical of reflection-in-action [Schön 1983]. This contribution sits within that tradition, extending it toward curriculum governance as a domain in which diagrammatic drawing operates as a device that is not merely representational but constitutive.
In this paper, synapse denotes a specific property of diagrammatic drawing: the ability to make relationships operational –visible, negotiable, and reconfigurable– through shared representation. The notion is analytical, not neuroscientific: it designates a junction in which heterogeneous elements (disciplines, sequencing constraints, institutional responsibilities) can be connected, tested, and modified in diagrammatic form, and in which the outcome of each revision cycle becomes the starting point for the next.
To clarify its distinctive properties, it is useful to compare it with adjacent concepts. Boundary objects [Star, Griesemer 1989, p. 393] similarly coordinate actors with different languages, but they are typically pre-existing and stable: their strength derives from a structured agreement around an already consolidated artifact. By contrast, the synaptic surface is an artifact in the making: its stability is deliberately provisional, functional to the ongoing revision cycle, and its value lies in the tension between openness to modification and sufficient legibility to support comparison, consistent with perspectives that understand maps and mapping as processual, situated practices, continually remade in use [Kitchin, Dodge 2007, p. 335]. Unlike the interactive boundary object [Tharchen et al. 2020, p. 2], which locates the conditions for interdisciplinary interaction in the semantic polycentricity of a shared concept, the synaptic surface foregrounds its representational function: it is drawing as such that produces the conditions for negotiation, not merely the conceptual space in which negotiation takes place. Finally, relative to external representation [Larkin, Simon 1987, pp. 65-66], the synaptic surface is a collective and institutional device: its function is not only to compress complex relationships into a perceivable form, but to stabilize them sufficiently so that they can be discussed, attributed, and traced over time through dated iterations.
From this perspective, the curricular diagram takes the form of a relational map: not in the cartographic sense, but in the sense argued by Corner [1999, p. 213], for whom the map does not record a pre-existing territory but institutes it by assigning weights, building sequences, and making visible dependencies that would otherwise remain tacit. Applied to a curriculum, this means that the diagram of the study plan does not describe an order that is already given: it produces that order through each revision cycle, making it inspectable and modifiable by the actors involved.

Context and initial issues

The case concerns the revision of a four-year bachelor's degree program in Design-Engineering, delivered entirely in China within a Sino-Italian joint program, with Italian faculty accounting for approximately one third of the teaching staff. The revision started from the existing study plan (in place since 2022) and from a set of issues identified through the school's governance structure and consultations with teaching staff. On the Chinese side, the

partner institution provided a synthesis of issues reported recurrently by students. On the Italian side, a working group representative of the involved departments and disciplinary areas was established.
The issues initially identified included: overlaps in course content; misalignments between the syllabi and what was delivered in some courses; and a distribution of credits and contact hours that was not always consistent [1]. The absence of a professional internship was also noted, together with the need to make course sequencing more legible by clarifying dependencies and progressions along the pathway. Finally, the need emerged to integrate and position new content more explicitly (including the role of AI) and to address some gaps in cultural-area content, improving coordination across courses and among the institutional components involved (fig. 1).
The aim was therefore to make sequencing, disciplinary interfaces, and pathways explicit to a degree sufficient to support negotiation and the partner's subsequent validation [2].

Methodology

The process began with an analysis of the existing study plan and the set of issues collected through the program's governance structure and consultations with teaching staff. The Chinese partner's synthesis of student notes was used to identify problems, not as evaluative data [3]. The Italian partner established a multi-department working group to represent the disciplines involved, under the coordination of the Dean of the School associated with the program. Each member conducted informal consultations with instructors in their department and with the departmental coordinator, consolidating constraints and priorities. The outcome was then prepared for submission to the joint program governance (Academic Committee [4] and partner review).
The activities did not follow a linear sequence, but rather a combined workspace in which a collaborative digital diagramming environment [5] and a traceable mapping file [6] were used in parallel as synchronized views of the same evolving curricular model. The collaborative environment supported diagrammatic drawing to externalize alternative structures, dependencies, and pathway hypotheses; the mapping file supported the work through coding and the rapid generation of

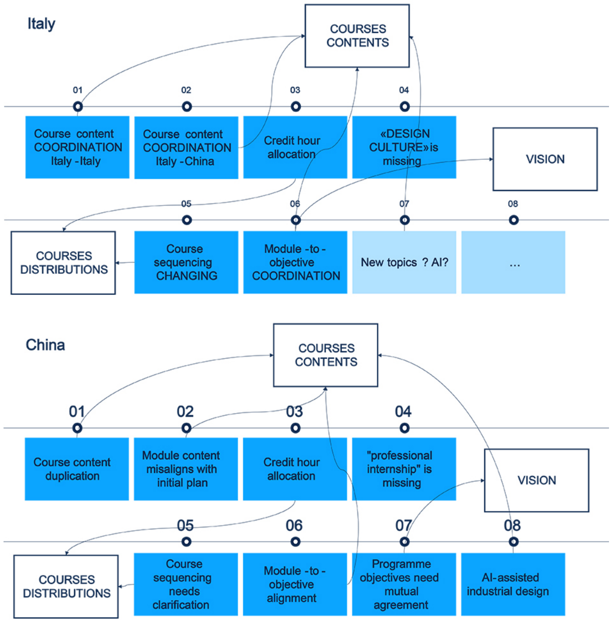


Fig. 1. Mapping of issues identified by the two partners of the joint program for the bachelor's degree in Design-Engineering (author's elaboration).

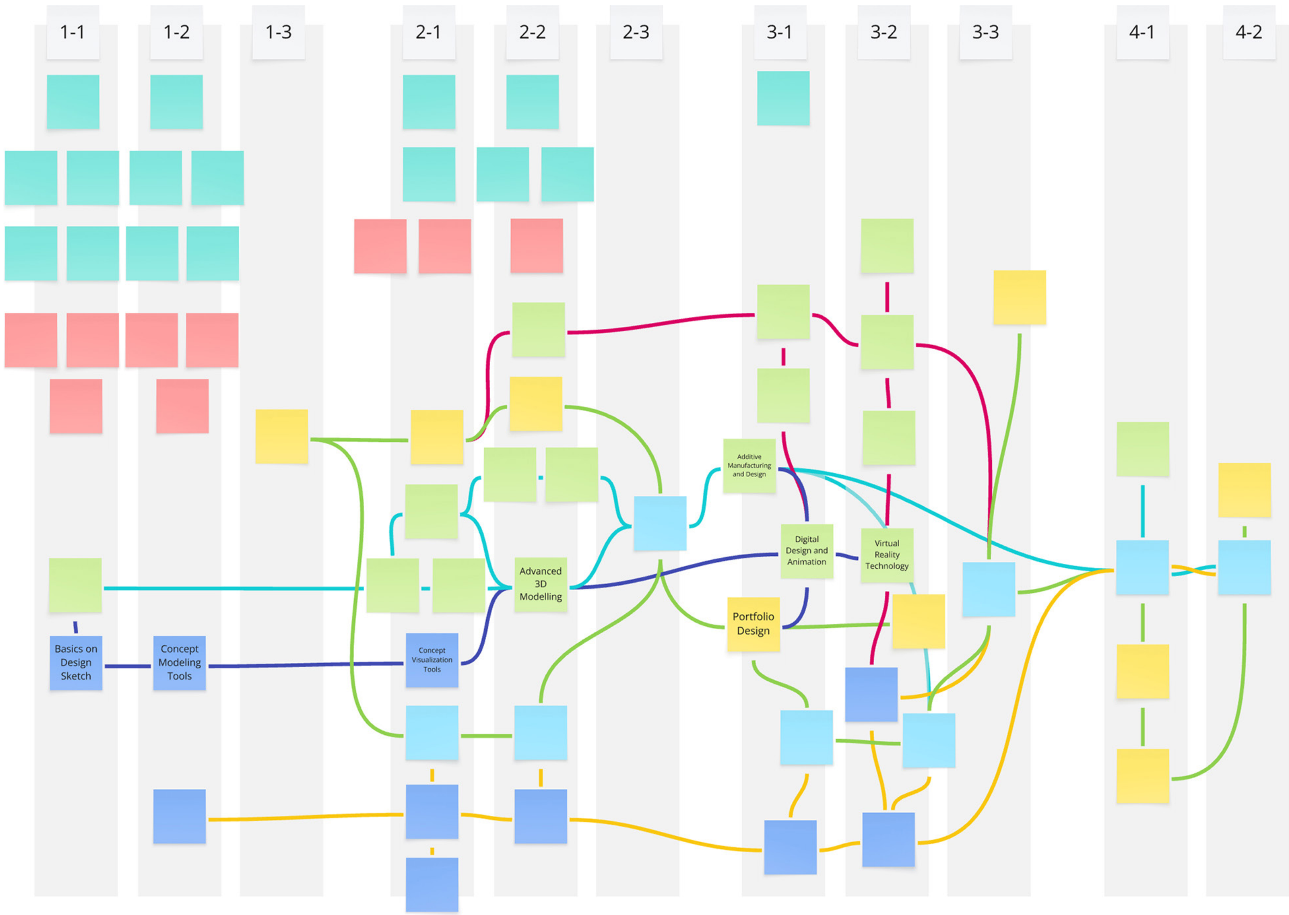
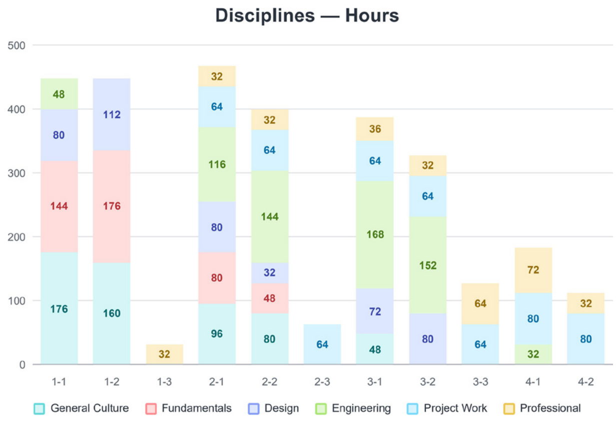


Fig. 2. Overview map: columns represent semesters; boxes represent courses; colors indicate Disciplines and lines show Pathways (author's elaboration).

structural charts. Within the adopted methodology, drawing makes it possible to explicitly document differing terminological and linguistic interpretations, serving as crucial support in defining and specifying the methodologies, techniques, and operational procedures employed in recalibrating the study plan [Ciammaichella, Menchetelli 2022, p. 8]. During each meeting, the group repeatedly moved between the two environments to discuss and immediately test proposed changes against their structural implications. The workspace therefore operated as a synaptic surface: an interface in which relationships became visible, negotiable, and traceable over time.
The group then recognized that a classification based solely on Disciplines would not be sufficient to represent the program's complex architecture and its transdisciplinary trajectories. A two-level model was therefore built: Disciplines and Pathways. Disciplines are mutually exclusive categories (each course in the plan is assigned to one Discipline only), useful for preserving disciplinary integrity and enabling quantitative aggregation; Pathways are non-exclusive trajectories (each course may belong to more than one trajectory), oriented toward content and sequencing and intended to make educational routes communicable and debatable among stakeholders.
Assignment to Disciplines followed explicit rules. The assignment was based on syllabi and teaching responsibility, with borderline cases resolved by the working group.
The five Pathways were derived from syllabi and interviews with coordinators to make explicit and optimize trajectories that were already implicitly present and to justify sequencing decisions. Because membership in Pathways can be multiple, delivered hours were not aggregated at the Pathway level to avoid double counting; instead, Pathways were used as a narrative and representational layer for sequencing logic, transparency, and multidisciplinarity. The group also proposed targeted reallocations of topics across courses and refinements of syllabi to recalibrate complexity when a course was moved within the study plan.
Structural checks used contact hours [1] as a comparable proxy for delivered teaching load, and charts to examine distributions and imbalances across semesters and Disciplines. Short summer terms are included in the mapping but have limited impact on overall distributions.



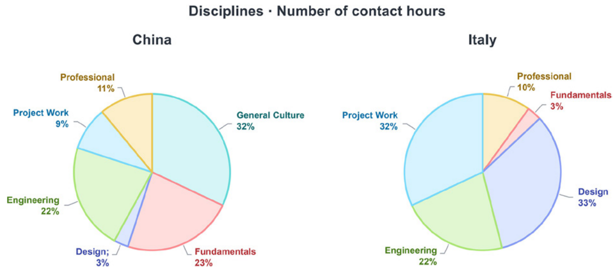


Fig. 3. Distribution of delivered hours by semester, aggregated at the Discipline level (author's elaboration).

Fig. 4. Percentage breakdown of delivered hours by Discipline, by teaching responsibility across the two institutions (author's elaboration).

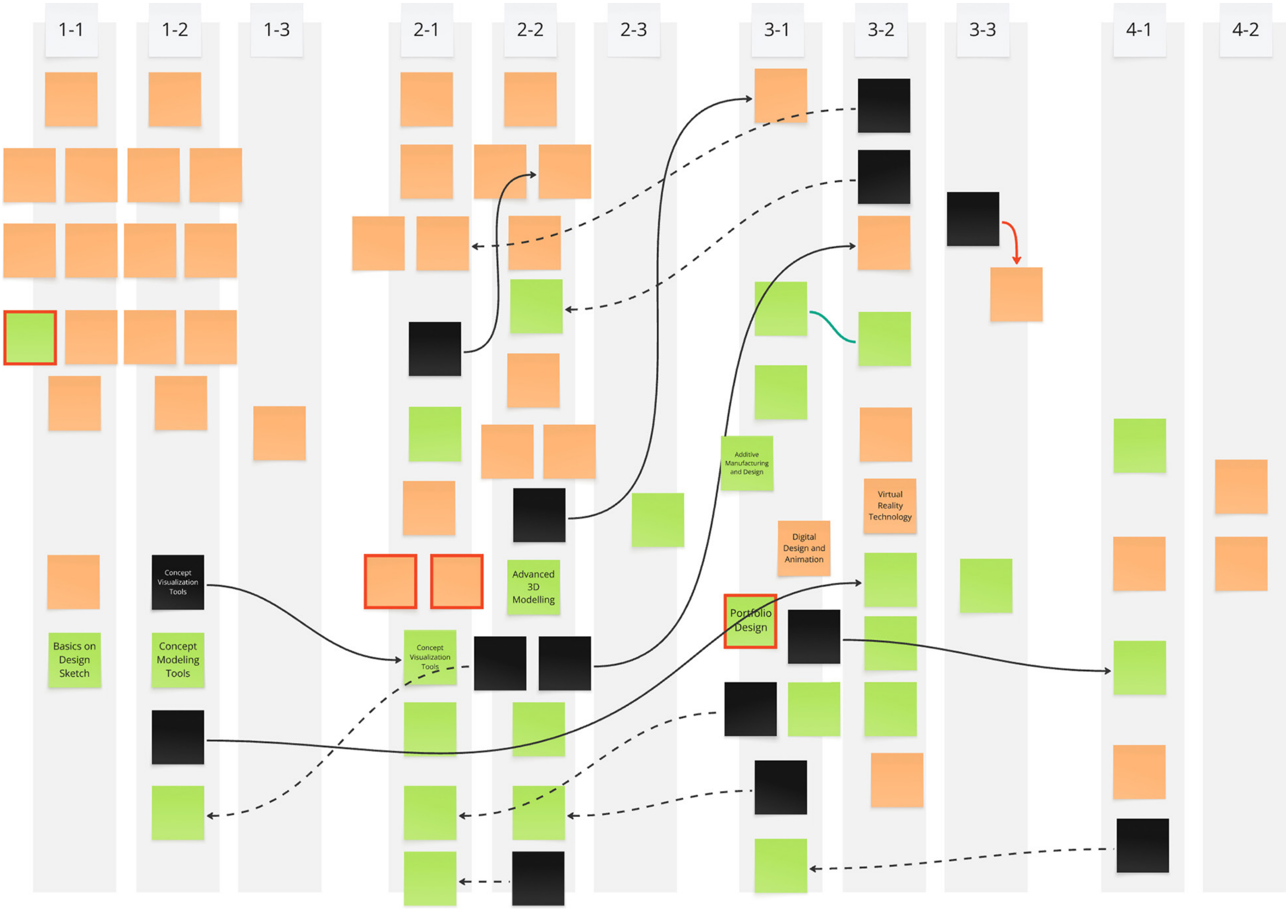
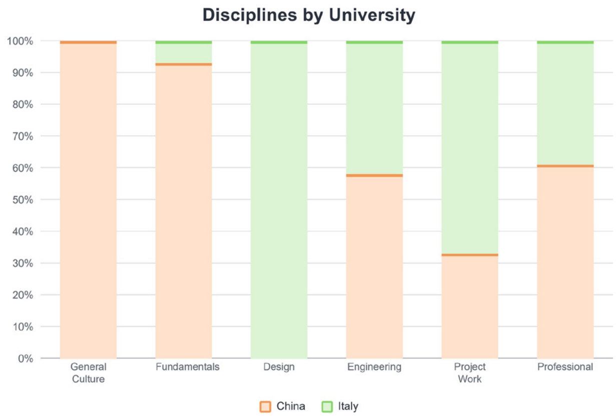


Fig. 5. Map of course movements in the study plan: boxes represent courses grouped by teaching responsibility (China vs. Italy) (author's elaboration).

The process unfolded through four co-design sessions between late 2024 and early 2025, interspersed with asynchronous revisions between sessions. Between sessions, the board in the collaborative digital diagramming environment remained open; changes were flagged with visual markers and reviewed collegially before being consolidated in the traceable structured mapping file. The output is a consolidated working version intended for partner validation and further refinements prior to implementation.
The method produces structural evidence: explicit relationships, sequencing logics, pathway visibility, hour-based coherence, and decision traceability. It does not claim learning or employability outcomes; such outcomes can only be assessed after implementation, through future cohorts.

Results

At the program level, the process produced a combined set of artifacts: two diagrammatic representations of the study plan (one to track course movements and highlight redesign operations, and another to formalize Disciplines and Pathways) and a traceable structured mapping file with embedded charts, through which the redesign becomes legible as a curricular architecture rather than as a list of modules. Selected charts generated in the mapping file were also embedded into the boards of the collaborative digital diagramming environment to maintain a single visual workspace, integrating qualitative exploration with quantitative checking. In addition, pathway-specific representations were produced to describe the logic of interdisciplinary trajectories in greater detail.
In the proposal documents, this diagrammatic strategy is framed as a shift from a previous organization based on modules and rigid schemes toward a structure organized through two concurrent classification levels.
The main output is therefore the two-level curricular model: mutually exclusive Disciplines and non-exclusive Pathways that cut across multiple Disciplines (fig. 2). This separation preserves the multidisciplinarity of trajectories while enabling hour-based aggregation only where coding is exclusive. Pathways are described as interconnected perspectives, whose overlaps become visible when courses appear in more than one



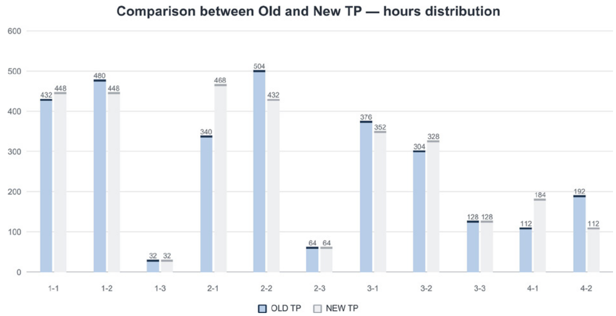


Fig. 6. Percentage breakdown of hours by Discipline by teaching responsibility (China in orange and Italy in green, author's elaboration).

Fig. 7. Comparison between the previous study plan (OLD TP) and the redesigned proposal (NEW TP) in the distribution of delivered hours by semester (author's elaboration).

trajectory. Accordingly, quantitative aggregation is performed only at the Discipline level (figs. 3, 4), while Pathways are treated as content- and sequencing-oriented trajectories that support shared understanding among stakeholders.
Another output is the surface of change that externalizes redesign operations (moves across semesters, splits, new courses, and changes in teaching responsibility), enabling stakeholders to discuss what changed and why without relying on tacit knowledge (fig. 5). Supporting this, a compact set of hour-based charts built at the Discipline level enables lightweight checks of the plausibility of the redesigned architecture across the four years and facilitates iterative corrections when imbalances across semesters or Disciplines emerge.
Finally, the proposal is explicitly positioned as a consolidatable working version, intended for further negotiation and refinement with the Chinese partner (first: structural evidence and traceable decisions; then: operational implementation and evaluation) (figs. 6, 7).

The Representation Pathway as a synaptic spine: a grammar of progression and the properties of diagrammatic drawing

In this paper, the Representation Pathway is not merely an applied example, but the site where the theoretical properties of the synaptic surface become verifiable through structural evidence. Choosing the representation strand as a privileged field of observation is not neutral: it is in this domain that drawing can examine itself as an object of study, showing how progression across methods and tools of representation can be articulated, discussed, and transformed through shared diagrammatic drawing.

The diagram as a grammar of progression
The Pathway was not constructed as a catalog of courses, but as a relational structure that expresses a grammar of progression. The distinction is fundamental: a list enumerates elements; a diagram institutes relationships among them, assigning orientation, dependency, and direction. The difference is not aesthetic but epistemic: in a diagram, ordering becomes arguable, contestable, and modifiable. In this case, the grammar is organized around representational modalities sequenced not by convention or historical inertia, but by recognized and formalized cognitive and technical dependencies.
The 2D space (*Engineering Drawing*; *Basics on Design Sketch*) establishes the base: literacy in drawing as a language, through the complementarity of standardized technical drawing, freehand drawing, and basic two-dimensional graphics. The 3D space then branches into two strands –*Modeling* and *Visualization*– which are not parallel but interdependent: visualization is enabled by, and presupposes, the existence of a model. This dependency constraint, which becomes an arrow in the diagram, is precisely what the synaptic surface renders negotiable: the decision to place *Concept Visualization Tools* after the first modeling module was not adopted by convention but argued for and traced as an explicit redesign operation (fig. 8). The diagram made this dependency visible, and therefore discussable.

The synaptic surface as an interdisciplinary junction
A second property highlighted by the pathway is the interstitial nature of diagrammatic drawing with respect to Disciplines. The Representation Pathway is not a disciplinary silo: the spine distributes courses across distinct Disciplines and makes interfaces with other Pathways legible through concrete junctions. *Additive Manufacturing* and *Design* function as a bridge between representation and fabrication, consistent with the program's manufacturing trajectories; *Digital Design* and *Animation and Virtual Reality Technology* connect the progression of representation to digital and immersive systems. These connections were not explicitly described in the pre-existing syllabi: they were produced –not discovered– through the shared diagramming process.
What the synaptic surface generates is not a description of relationships that already exist, but their construction as an inspectable and negotiable structure. The diagram does not record that *Engineering Drawing* precedes *Concept Modeling Tools*; it institutes that precedence as a foundational cognitive relationship on which subsequent choices can be discussed, decided, and grounded. In this sense, each arrow in the diagram is a design act, not a statement of fact. This distinguishes diagrammatic drawing from tabular mapping: the table shows where courses sit in the study plan; the diagram shows why they sit there and how they relate to one another.

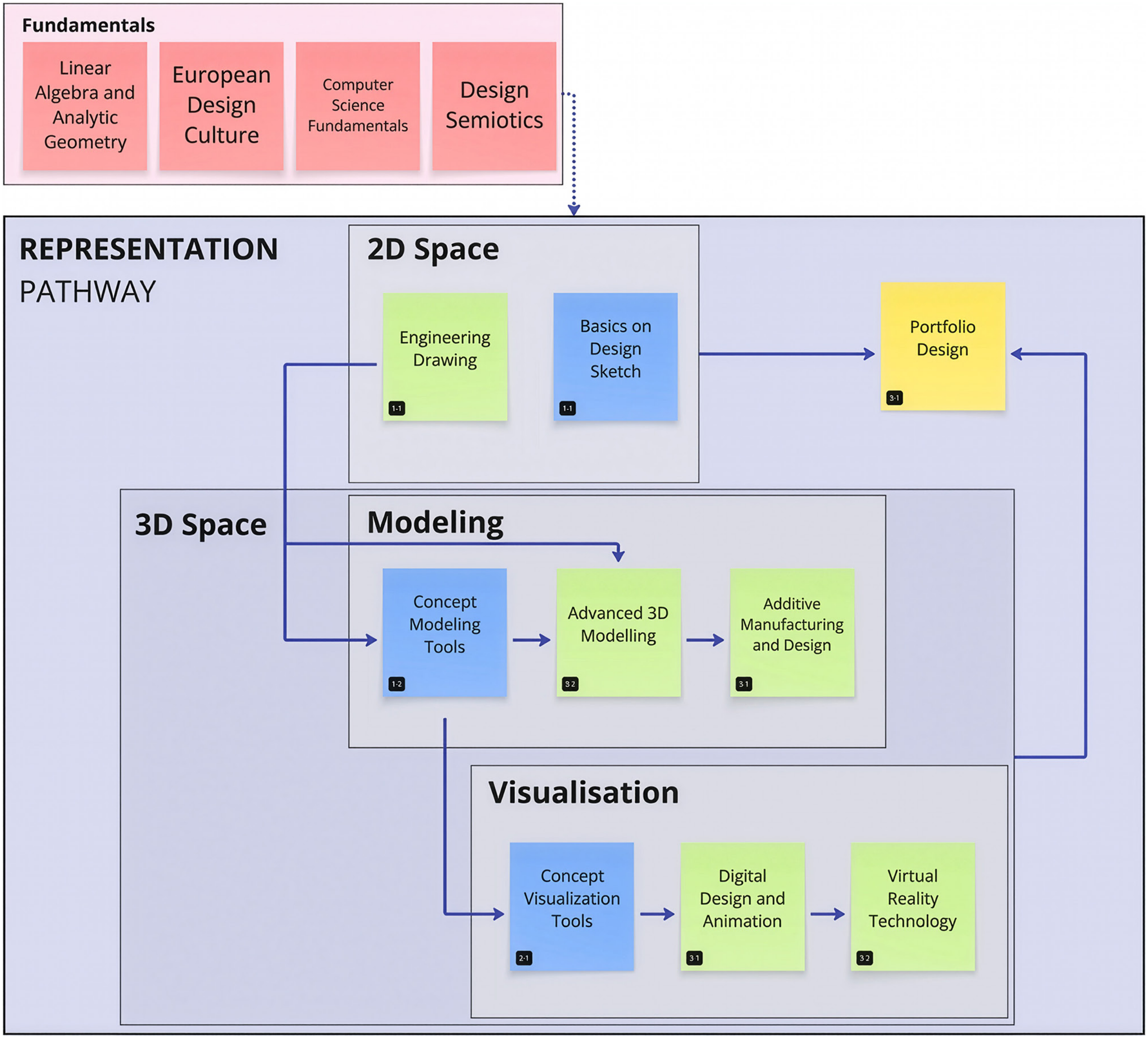


Fig. 8. The Representation Pathway as a synaptic spine. The diagram makes explicit a grammar of progression by modality (author's elaboration).

China/ Italy	TEACHING PERIOD (year-sem.)	Course Name	XJTU Credits	Hours
China	1-1	Engineering Drawing	3	48
Italy	1-1	Basics on Design Sketch	2 (was 3)	80 (was 96)
Italy	1-2	Concept Modeling Tools	3	64
Italy	2-1 (was 1-2)	Concept Visualization Tools	2	48
Italy	2-2	Advanced 3D Modeling	3	64
China	3-1	Digital Design and Animation	2	64
Italy	3-1	Additive Manufacturing and Design	2	40
Italy	3-1	Portfolio Design (NEW elective)	1	32
China	3-2	Virtual Reality Technology	2	40

Tab. 1. Semester-by-semester sequence of the Representation Pathway, with teaching responsibility, credits, and delivered hours.

Traceability as an epistemic property of diagrammatic drawing
A third property emerges from the semester-based mapping (tab. 1): the traceability of redesign operations. The semester-indexed spine is not merely a managerial tool, but an epistemic artifact: it preserves the memory of decisions, makes visible what has changed relative to the previous configuration and why, and enables the curriculum's rationale to be questioned over time. In this sense, the Pathway functions as an active archive of curricular rationality: a structure that can be interrogated, challenged, and updated without losing track of the reasoning that produced it.
This addresses a structural weakness of low-formalization diagrams: the inability to distinguish intentional organization from historical sedimentation. By maintaining openness and traceability simultaneously (the diagramming environment remained open between sessions; changes were flagged with visual markers and iteratively consolidated in the mapping file), the synaptic surface produces a legible stratification of design rationality. An archive not as a static artifact, but as a dynamic record of curricular decisions.

What this adds to the disciplinary debate in drawing
The Representation Pathway demonstrates three properties of diagrammatic drawing that transcend the case study: the diagram constructs and orients relationships rather than merely making them visible; progression across representational modalities requires the externalization of cognitive dependencies that otherwise remain tacit without a shared graphic artifact; and decision traceability produces an epistemic memory of design rationality, a necessary condition for any responsible process of curriculum governance.

Discussion

While adopting the design curriculum as a case study, this paper ultimately examines drawing as a meaning-making device operating within multi-stakeholder governance contexts. The Sino-Italian joint program serves as the material through which properties of diagrammatic drawing –performative capacity, negotiability, and traceability– can be observed more clearly than they would in single-institution or

single-disciplinary settings. The complexity of governance (two universities, two cultures, two validation systems) is therefore not a limitation of the research, but the condition that makes these properties observable in their actual operation.
Within the Sino-Italian setting, shared artifacts reduced ambiguity across disciplinary languages and institutional cultures: the collaborative digital diagramming environment remained open for flagged proposals, changes were attributable to authenticated accounts, and they were reviewed collegially before consolidation. Partner validation is still ongoing, and the process has been slowed by leadership changes; the method should therefore be understood as support for responsible negotiation rather than as a guarantee of agreement.
Finally, the approach is explicitly oriented towards stakeholders, but at present it remains a design intention rather than an evaluated outcome: a student-facing map is still a project aim. Once partner validation is completed, the same representational infrastructure can support the publication of legible pathway narratives and post-implementation observation of effects.
In drawing discipline practice, the shift from descriptive artifact to operative artifact –from a map that documents to a map that institutes relationships, guides decisions, and reshapes collective understanding of the problem– remains an open theoretical question that has not yet been systematically examined in the context of educational governance. Through the curricular case, this contribution offers structural evidence that can inform that debate, and it suggests that the concept of diagrammatic drawing can be extended to domains in which representation functions simultaneously as an analytical instrument and a constitutive act.

Conclusions

This paper presented a representation-centered process for curriculum redesign within a multicultural, multidisciplinary university program. Treating a collaborative digital diagramming environment and a traceable structured mapping file as a synaptic surface produced a two-level model (Disciplines and Pathways), explicit sequencing logics, and traceable change operations supported by conservative hour-based checks.
The applied example of the Representation Pathway shows how diagrammatic drawing can make progression across representational modalities explicit and negotiable. The proposal remains a consolidated working version pending partner validation; any syllabus refinements are currently at the proposal stage and contingent on approvals, and a student-facing map belongs to the implementation phase.
Ultimately, the study argues that drawing, understood as diagrammatic representation, can operate as an organizational device that renders curricular relationships actionable, not merely describable.

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Notes

[1] In this paper, contact hours refer to scheduled, in-person teaching hours. Independent study and assessment time are excluded [European Commission 2009].

[2] The figures prioritize the visualization of structural relationships to reduce confidentiality risks; the Representation Pathway is described in detail as an applied example.

[3] Because the procedures used to collect and aggregate student-reported data were managed by the Chinese partner, these data were treated as secondary evidence rather than as an evaluative dataset.

[4] The Academic Committee is the body responsible for course design and quality assurance. It includes faculty and administrative staff from both universities.

[5] The collaborative digital diagramming environment (MIRO) supported exploratory visualization and shared diagrammatic drawing.

[6] The structured mapping file (Excel) enabled systematic coding, the generation of comparative charts, and change traceability.

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