

ASP XIX Cycle **Spring School 2023**

DESIGN METHODS AND PROCESSES

COORDINATOR GAETANO CASCINI

The aim of the course is to introduce the ASP students to the wide range of existing *design methods*, from the descriptive models for analysing *design processes* and behaviours to the prescriptive tools that provide a structured and multi-disciplinary approach to design.

The students will become aware of the existing approaches to design through the experiences of experts from different fields, by sharing a common lexicon on design methods and being introduced to the main stages of product/service design.

Moreover, the course will allow experience the application of illustrative design tools within a collaborative design contest.

The course consists of lectures, tutorials and team-working sessions:

- The lectures will develop a general framework of design theory, methods and approaches, their purposes and key characteristics; different points of view and approaches provide the fundamentals and all the criteria to orient the students for assimilating a structured approach to design according to their personal attitude and expectations.
- Tutorials (to be held in the residential week on 22-26 May 2023) propose practical examples of specific tools and techniques suitable to guide the main design phases of analysis, synthesis, and choice. Specifically, the tutorials focus on the organization of a collaborative design activity; on the analysis of product and service requirements for a proper organization of the design tasks; on the generation of conceptual solutions with the support of inventive heuristics; on the assessment of the proposed concepts and the choice of the preferred solution.
- Team working on the ASP projects will be organized in the residential week. This activity will take into account technical aspects pertaining to both Winter and Spring schools, and can be considered to be useful to the students, allowing them to familiarize with the contents of their ASP projects and to start working on them on a sound methodological path.

Overall, lectures, tutorials and team-working sessions provide students with a comprehensive overview of the aims and scopes of *design methods and processes*, providing the ASP students with theoretical and practical aspects on:

- The main classification schemes of design approaches;
- Cognitive studies on designing;
- Design creativity and its influential factors;
- Involving the end user in the design process;
- Current and future challenges of design methods;

- How to exploit team competencies in a collaborative design activity;
- How to build an exhaustive design specification;
- How to stimulate idea generation;
- How to select the most suitable design concept among several ones.

Organization

- Lectures focused on theory will be held in blended mode (on-site and online) from April 18th to May 16th, with synchronous lectures (i.e., lecturer and students being present at the same time) followed by Q&A sessions.
- One of the lectures, held by Prof. Pascal Le Masson, has been pre-recorded and the online meeting will be dedicated to examples and discussion. ASP students are requested to watch the video-lecture in advance.
- Two meetings will involve design experts who will share experiences of their professional careers in diverse innovation projects.
- One face-to-face event will take place at PoliTO: on this occasion, selected design projects presented by ASP students will be discussed against the reference models introduced in the online lectures.
- The “Dynamics of Innovation” and the “Design Methods and Processes” schools have coordinated their syllabus in order to lead to a week-long “school” to be held with all students present on May 22nd-26th at MIND District, Milan. This joint school will focus on tutorials and group work, to be carried out on the ASP projects the students have been assigned to.

Lecturer and Speakers

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 Marianna Nigra (Politecnico di Torino)
 Chipten Valibhay (MINES ParisTech – PSL Research University)

Lectures and Speeches

April 18th, 18:00-19:30 CEST (online only)	Engineering Design, what are we talking about? Gaetano Cascini
April 20th, 18:00-19:30 CEST (online only)	Innovating today – why design theory matters* Pascal Le Masson <i>*ASP students are requested to watch the video-lecture in advance</i>
April 27th, 18:00-19:30 CEST (live @ PoliMI classroom B8.0.3 + online)	Narrative-based Design: designers as storytellers Francesca Piredda
May 2nd, 18:00-19:30 CEST (online only)	Sustainable Design: challenges, opportunities and trends Daniela Pigosso
May 4th, 18:00-19:30 CEST (live @ PoliMI B8.0.3 classroom + online)	Data-enriched products and data-enabled services: the role of Engineering Design in data-driven innovation processes Andrea De Mauro
May 9th, 18:00-19:30 CEST (online only)	Design strategies to help users embrace new technologies for a better future Deborah Nas
May 11th, 18:00-19:30 CEST (live @ PoliTO classroom 4D + online)	You are the Designers – Discussion with ASP students on exemplary design experiences ASP students from PoliMI & PoliTO
May 16th, 18:00-19:30 CEST (live @ PoliMI classroom DeDonato + online)	Design creativity and design cognition – Closing session Gaetano Cascini

Course format

What	Spring School 2023
Where	Online + PoliMI + PoliTO + MIND District
When	April – May 2023

Papers bibliography *(student's individual work)*

Introduction to Design Methods and Design Theory

- Nigel Cross (2008) Engineering design methods strategies for product design Wiley (4th Edition): Chapter 3 "The Design Process", pp. 29-42.
- David Wynn and John Clarkson (2004) Models of designing, in "Design Process Improvement: A review of current practice" John Clarkson and Claudia Eckert (Eds), Springer; 1st Edition, pp.34-56.
- Kruger, C. and Cross, N. (2006) 'Solution driven versus problem driven design: strategies and outcomes', Design Studies, Vol. 27, No. 5, pp.527-548.
- G. Pahl, W. Beitz (2007) Engineering Design a systematic Approach, Third Edition: Ch 1, Section 1.1: The scope of design, pp. 1-9; Ch 4, Product Development Process, pp. 125-141.
- Le Masson, P. (2017). "C-K theory: A Model for Creativity." Paris Innovation Review, April 2017.
- Hatchuel, A., Le Masson, P., Reich, Y., and Subrahmanian, E. (2018). "Design theory: a foundation of a new paradigm for design science and engineering." Research in Engineering Design, 29, pp. 5-21.

Cognitive aspects of Design

- Gero, JS and Kannengiesser, U (2014) The Function-Behaviour-Structure ontology of design, in Amaresh Chakrabarti and Lucienne Blessing (eds), An Anthology of Theories and Models of Design, Springer, pp. 263-283.
- Cascini G., Fantoni G., Montagna F.: "Situating Needs and Requirements in the FBS framework", Design Studies, 34, 2013, pp. 636-662.
- Gero, JS, Jiang, H and Williams, C (2013) Design cognition differences when using unstructured, partially structured and structured concept generation creativity techniques, International Journal of Design Creativity and Innovation 1(4) 196-214.
- Purcell, T., Williams, P., Gero, J. S. and Colbron, B. (1993). Fixation effects: do they exist in design problem solving? Environment and Planning B, 20: 333-345
- Vieira, S., Benedek, M., Gero, J., Li, S., & Cascini, G. (2022). Design Spaces: Neurophysiological Activations in Constrained and Open Design Tasks.

User experience

- Brockman, J. (ed.), What to Think About Machines That Think: Today's Leading Thinkers on the Age of Machine Intelligence. Harper Perennial (2015)
- Buxton, B. Sketching user experiences: getting the design right and the right design. Morgan Kaufmann (2010)
- Kuniavsky, M., Goodman, E. and Moed, A. Observing the user experience: a practitioner's guide to user research. Morgan Kaufmann (2012).
- Norman, D.A. Living with complexity. Mit Press (2011).
- Pucillo F., Cascini G., A framework for user experience, needs and affordances, Design Studies, 35, 2014, pp.160-179.

Innovation and Product Development

- Ulrich K., Eppinger S. (2007), "Product Design and Development", 4th edition, Mc Graw Hill.
- Adner R, Kapoor R, 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, 31: 306-333.
- Christensen CM, Verlinden M, Westerman G, 2002. Disruption, disintegration, and the dissipation of differentiability. *Industrial & Corporate Change*, 11(5): 955-993.
- Borgianni Y., Cascini G., Pucillo F., Rotini F.: "Supporting Product Design by Anticipating the Success Chances of New Value Profiles", *Computers in Industry*, 64(4), 2013, pp. 421-435.
- Montagna, F.; Cantamessa, M.; Cascini, G., 2016. Design for Innovation - a methodology to engineer the innovation diffusion into the development process. *Computers in Industry*, 75(3): 46-57.
- Casagrande-Seretti, A., Montagna, F., & Cascini, G., 2019. A decision support model to assess technological paradigms. *International Journal of Technology Management*, 80(1-2), 61-84.
- Bacciotti D., Borgianni Y., Cascini G., Rotini F., 2016. Product Planning techniques: investigating the differences between research trajectories and industry expectations. *Research in Engineering Design*, 27(4):367-389.

Collaborative design

- Singh, V, Dong, A and Gero, JS (2011) How important is team structure to team performance? in S Culley, B Hicks, T McAloone, T Howard and P Badke-Schaub (eds), *Human Behaviour in Design*, Design Society, Glasgow, pp. 7-117-126.
- Kleinsmann M. (2006) Understanding collaborative design. PhD Thesis at TU Delft, Faculty of Industrial Design Engineering

Data-driven design

- Porter, M.E. and Heppelmann, J.E. (2014), "How Smart, Connected Products Are Transforming Competition", *Harvard Business Review* 92, No. 11, pp. 64-88.
- Bharadwaj, N. and Noble, C. (2017), "Finding Innovation in Data Rich Environments", *Journal of Product Innovation Management*, Vol. 34 No. 5, pp. 560-564. doi: 10.1111/jpim.12407
- Austin, R.D., Devin, L. and Sullivan, E.E. (2011), "Accidental Innovation: Supporting Valuable Unpredictability in the Creative Process", *Organization Science*, Vol. 23 No. 5, pp. 1505-1522. doi: 10.1287/orsc.1110.0681
- Dalpiaz, F., Giorgini, P. and Mylopoulos, J. (2013), "Adaptive socio-technical systems: a requirements-based approach", *Requirements Engineering*, Vol. 18 No. 1, pp. 1-24. doi: 10.1007/s00766-011-0132-1
- Autio, E., Nambisan, S., Thomas, L.D.W. and Wright, M. (2018), "Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems", *Strategic Entrepreneurship Journal*, Vol. 12 No. 1, pp. 72-95. doi: 10.1002/sej.1266

Sustainable design

- Dougherty, D. and Dunne, D.D. (2012), "Digital Science and Knowledge Boundaries in Complex Innovation", *Organization Science*, Vol. 23 No. 5, pp. 1467-1484. doi: 10.1287/orsc.1110.0700
- McAloone, T., Pigosso D. (in press) Developing products with enhanced environmental performance
- McAloone, T., Pigosso D., Rozenfeld H. (2015) Characterization of the State-of-the-art and Identification of Main Trends for Ecodesign Tools and Methods: Classifying Three Decades of Research and Implementation. *Journal of the Indian Institute of Science*, 95(4)

Design Specification

- Ericson, Å., Müller, P., Larsson, T., & Stark, R. (2009). Product-Service Systems: From Customer Needs to Requirements in Early Development Phases. *Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference*, Cranfield University, England, 1-2 April, 62-68.
- Wang, M., & Zeng, Y. (2009). Asking the right questions to elicit product requirements, *International Journal of Computer Integrated Manufacturing*. 22, 283-293.
- Miaskiewicz, T., & Kozar, K.A. (2011). Personas and user-centered design: How can personas benefit product design processes? *Design Studies* 32, 417-430.
- Becattini N., Cascini G.: "General-purpose requirements checklist for improving the completeness of a design specification", *Proceedings of the DESIGN 2014 13th International Design Conference*, Dubrovnik, Croatia, 19-22 May 2014, pp.111-120.

Heuristics for Problem Solving

- Cascini G.: "TRIZ-based anticipatory design of future products and processes", *Journal of Integrated Design & Process Science*, 16(3), 2012, pp. 29-63.
- Rosa F., Cascini G., Baldussu A.: "UNO-BID: Unified Ontology for Causal-Function Modelling in Biologically Inspired Design", *International Journal of Design Creativity and Innovation*, 3(3-4), 2014, pp.177-210.

Concepts Assessment and Choice

- Scott M.J., (2007) Quantifying uncertainty in multi-criteria concept selection methods, *Research in Engineering Design*, 17:175-187.
- Saaty T. (1990), How to make a decision: The analytic hierarchy approach, *European Journal of Operational Research*, 48, 9-26.
- Saaty T. (2008) Decision making with the analytic hierarchy process, *Int. J. Services Sciences*, 1(1), 83-98.