10. Annexure

10.1. Annexure A. Elisava

10.1.1. Objectives

The subjects that Elisava has regarding graphical expression and representation are Computer Aided Design in 2D, Computer Aided Design in 3D, Graphical Expression I and Graphical Expression II. The set of these four subjects is the same, the main objectives are:

- Develop creative techniques from all kind to analyze, synthetize and resolve necessities.
- Use the scientific-technological language, not only orally but also written, with the own terminology of design and engineering.
- To organize and plan accordingly the tasks bearing in mind the optimization of resources and time.
- To dominate and apply properly in every moment the knowledge of the own profession and to maintain a continuous learning motivated by the desire to improve.
- To demonstrate that not only the knowledge one has is from advanced books but also from the avant-garde of investigation.
- To learn how to transmit information, ideas, problems and solutions to specialized or not public.
- To be able to apply the aesthetic and expressive resources in the configuration of product designs.
- To apply the scientific foundations to the conception of products.
- Apply the knowledge of materials, technology and production processes to the products' development.
- To apply the knowledge of graphical, artistic and technical expression to visualize the ideas, develop solutions and generate the proper technical documentation.

10.1.2. Learning outcomes

Once these different subjects have been passed the students should be able to use the informatic tool of CAD 2D and 3D for the application of the graphic expression of engineering, resolve formal problems with 2D and 3D geometries, recognize the tridimensional geometric forms of the models and the utility of the existent and imaginary things.

They should have learned to apply the proper terminology of the CAD system, along with the exemplification, illustration, interpretation and complementation of any type of graphic documentation, print properly the drawings in the normalized formats and papers to make up the collection of necessary drawings and to analyze, choose and apply the adequate steps to develop the drawings the right way.

Regarding computed aided design in 3D, the approach of different work strategies in the parametric modeling of objects should be applied, problems with 3D geometry may be resolved, the viability and the options of a determined parametric proposal of modeling should be evaluated and the diverse components of a representation should be organized in a clear and precise way.

Following up the knowledge that Computer Aided Design in 2D and 3D provide, the subjects Graphical Expression I and II make the students able to see the morphology of the objects from a geometric view, deduce the importance of any kind of conditioners that may influence on the form and the operation of the objects and discover the functionality of the objects from a manipulation and technical behavior point of view.

They are also able to define and represent a technical project in a complete, precise and clear way, define the function, the construction and the quality of the pieces, use the rules of Graphical Expression applied to product engineering and do drawings.

The structure of these four subjects that Elisava has, are very developed since all the contents can be distributed in four different subjects. Despite the fact that the duration of these subjects is shorter that the subject of Industrial Design, there is not enough time to explain all the contents that Elisava teaches, so the contents should be summarized to fit the time that Industrial Design has.

10.1.3. Contents

Computer Aided Design in 2D

1. CAD tool of representation in 2D
   1.1. Introduction
   1.2. Layers
   1.3. Tools of creation and modification of entities
   1.4. Property control
   1.5. Editing drawings and printing

1.5.1. Line values
1.5.2. Formats
1.5.3. Drawings' box
1.5.4. Scales

2. Geometry and regulatory graphic representation
   2.1. Flat geometry
   2.2. Sections
   2.3. Dimensioning
   2.4. Details

Computer Aided Design in 3D

1. Introduction to 3D parametric modeling
2. Creation components tools
   2.1. Basic
   2.2. Sketch function for the creation of pieces
   2.3. Advanced
   2.4. Introduction to modeling by behavior
   2.5. Surfaces
3. Assemblies
   3.1. Simple
   3.2. Subsets with assemblies
   3.3. Creation of complex geometry components in assemblies with subsets
   3.4. Generation of components from the set
   3.5. Operational organization in complex sets
   3.6. Visual control of sets
4. Basics of conceptual design
5. Tools for analysis of models
6. Dynamic visual treatment in project's presentations.

Graphical Expression I

1. Units in engineering
2. Regulated scales
3. Drawings' boxes
4. Accepted formats
   4.1. Margins
   4.2. Folding of planes

5. Printing
6. Types and uses of straight lines
7. Views
   7.1. Bottom view, front view and left side view
   7.2. European and American projection
   7.3. Cuts and sections (initial)
   7.4. Cuts and sections (with depth)
   7.5. Unused views
   7.6. Detail views
   7.7. Basic criteria of usage
8. Dimensioning
   8.1. Types of dimensions
   8.2. Dimensioning regulations (referents to style)
   8.3. Creation of dimensions' styles
   8.4. Dimensioning regulations (referents to dimensioning)
   8.5. Methods of dimensioning (except revolution)
   8.6. When to use each method
   8.7. Methods of dimensioning (pieces of revolution)
   8.8. Dimensioning symbology
9. Measurement tools
10. Springs
    10.1. Types of representation
11. Threads and screws
    11.1. Types of threads
    11.2. Metric representation
    11.3. Representation of other threads and screws
    11.4. Codification of regulated elements
    11.5. Other regulated elements
    11.6. Research of regulated and catalogues
    11.7. Representation of nuts, washers…
    11.8. Representation of threaded joints
12. Rivets
    12.1. Rivet methods
    12.2. Types of rivets
    12.3. Rivet representation
13. Bearings
    13.1. Types of bearings
    13.2. Representation

13.3. Mounting, supports and gasket openings

14. Surface finishes
    14.1. Types of surfaces
    14.2. Rugosity
    14.3. Surface state indicators
    14.4. Unused indicators
15. Tolerances
    15.1. Principle of interchangeability
    15.2. Types of tolerances
    15.3. Fabrication tolerances
    15.4. Dimensional ISO tolerances
    15.5. Dimensioning indications
    15.6. Tolerance calculus
    15.7. ISO adjustment system
    15.8. Selection and design
    15.9. Representation
    15.10. Adjustment calculus

Graphical Expression II

1. CAD 3D Environment
    1.1. 3D modeling of engineering projects
    1.2. Assembly of the pieces that make up the Project
    1.3. Dimensioning style
    1.4. Creation of drawings
2. Welds and welded sets
3. Surface states
4. Geometric tolerances
5. Pieces of molding and sets

10.2. Annexure B. Pratt Institute

10.2.1. Objectives

In this degree of Industrial Design, the subjects that have more resemblance to Graphical Expression are 2D Representation I and II and 3D Representation I and II. It has to be clarified that some of the simplest concepts that are needed to understand the concepts of this subjects are taught in previous subjects like Visualization, Representation and Concept or Space, Form and Process.

This means, that the contents of the subjects like 2D Representation I and II, 3D Representation I and II are more focused on advanced methods and don't have the part of understanding, reading and interpretation of space, since it's taken for granted.

The main learning outcomes that these subjects are looking for are:

- Upon graduation, students should be able to demonstrate a high level of competence in translating ideas into 2-D and 3-D form, implementing their aesthetic sensibility, critical thinking, and use of digital/analog tools.

- Students will have in-depth knowledge of the design process according to current professional practice, including research, ideation, refinement, prototyping and presentation, individually and in teams, using contemporary design thinking in the creation of superior products.

- Students will achieve a working knowledge of materials and methods of manufacture that incorporate principles of sustainability, ethics, and the global consequences.

- Graduates from the B.I.D. program will develop a humanistic approach to the needs of end-users from the point of view of interface, ergonomic, social, historical, and commercial perspectives.

10.2.2. Contents

2D Representation I

The course introduces and develops some 2D communication skills essential for the practice of Industrial Design and stablishes a base for the upcoming subjects. It starts

with the basics of ideational sketching and continues with alternate techniques, digital methodologies, and broader issues of graphics, symbolic representation, and presentation. Also, as it is one of the first subjects, the scope is always restricted to small objects.

3D Representation I

This course explores the structure of the three-dimensional visual relationship, studying and developing the student's skills in assessing the aesthetic, functional and conceptual aspects of form and space. Using the knowledge acquired in previous subjects, the three-dimensional sensibility is developed with a series of exercises, projects and lectures putting into practice the cognition, organization and articulation of the 3-D elements of line, plane, volume, space, tonal value, texture, color, and the synthesis of the 3-D principles of proportion, scale, balance, movement, grouping, hierarchy, structure and spatial tension that have been learned through the first year of the degree. In order to do so, manual and digital tools such as CAD programs are used in both the students' projects and exercises.

2D Representation II

Part two of 2D Representation is more focused on developing the basic skills learned in the first part, by starting to draw large-scale objects including furniture, interiors and exhibit spaces. Students also learn to convey subtleties of form, use, attitude and style in persuasive drawings and renderings. The course provides a more digital methodology to develop elements of graphic design, narrative and overall visual communication as it's much more common to draw digitally in the professional field instead of doing it manually.

3D Representation II

Part two of 2D Representation is more focused on developing the basic skills learned in the first part, by starting to draw large-scale objects including furniture, interiors and exhibit spaces. Students also learn to convey subtleties of form, use, attitude and style in persuasive drawings and renderings. The course provides a more digital methodology to develop elements of graphic design, narrative and overall visual communication as it's much more common to draw digitally in the professional field instead of doing it manually.

10.3. Annexure C. Royal College of Art & Imperial College

10.3.1. Philosophy of the programme

The programme mainly focuses on developing the skills of a new type of designer, with innovation focused thinking, refined design skills and engineering or technology mastery. The students shall exploit their creativity to not focus the object design only but to achieve commercial success instead.

The purpose of the master's degree combining both schools is to take advantage of the skills of different field and organizations, a predominantly technical university (Imperial College London) and a college of art and design (Royal College of Art). The aiming of this is to achieve a result that combines the technology and precision of science with the creative aspects of design. The course fosters a collaborative approach involving multidisciplinary team working and encourages external commercial involvement.

10.3.2. Learning outcomes

The learning outcomes that the course aims to achieve are separated in intellectual engagement, technical skills and professionalism. And these intended outcomes are:

Intellectual Engagement

- Develop innovative ideas that challenge the understanding of their practice and discipline.
- Apply the principles and methods of observation and research in developing innovative products.
- Demonstrate how their work has been informed by a global perspective on the social, cultural and political aspects of design.
- Assess the impact of design decisions on the sustainability of a product.
- Translate an understanding of the human form and ergonomics into user-centered design solutions.
- Document and present their work using a range of visual, audio and textual media.

Technical Skills

- Apply an in-depth understanding of machine elements in translating concept into functioning design.
- Test and evaluate design ideas through drawing, model making and prototyping.

- Select appropriate materials and processes for manufacture
- Employ concept mapping in gaining knowledge about the context of and use of a product.
- Integrate the use of enterprise tools in their design of their workflows.

Professionalism

- Take responsibility in developing project briefs and managing time and resources effectively.
- Collaborate effectively with peers in assigning roles, delegating tasks and communicating outcomes of group projects.
- Exploit an understanding of consumer psychology and commercial issues in marketing product solutions.
- Define their professional identity through an exploration of their own values, skills and the environments in which they seek to operate.

10.3.3. Learning and teaching methods

The course programme is of six term's duration spread over two years and it's mainly based in projects, although it is supported by a variety of other activities like lectures, skills-based workshops, seminars and practices all complemented by staff and teachers tutoring, not only for group projects but for individual as well.

In the group and joint tutorials, the students review their work with the staff and teachers discussing the flaws of its projects and taking notes to upgrade them while learning. The way these tutorials are developed require that the students present their works at least by a rapid oral presentation. This is done in order to enhance the skills of the students to present and defend their projects and criteria of doing.

The seminars and practices are a more relaxed way of testing their creativity and knowledge of the contents, since are individual and are done while having the tutoring of the teachers. Usually written feedback is not given, but verbal feedback can also be useful throughout the seminars.

10.4. Annexure D. Art Center

10.4.1. Learning outcomes

The program learning outcomes for the degree in Industrial Design are designed to produces abilities that make the students excel in their professional careers by developing not only the technical and technological area, but also the humanistic, social and business part to have a greater impact in society and the professional field and consequently be more confident in their work and successful.
The main outcomes that the degree tries to guarantee the students at the end of the courses are:

1. Listen, sense, and orient related to a given innovation context with appropriate actions and methods.
2. Frame, research and analyze an innovation context to understand the related systems and dynamics.
3. Identify strategic objectives, stakeholder value criteria, and metrics for relative success.
4. Scan, search-for, and filter information in various forms to rapidly gain intelligence for innovation context.
5. Apply tools and methods to develop appropriate future foresight and trend analysis for innovation context.
6. Employ appropriate research methods with empathy to discover important human dynamics related to innovation context.
7. Induct, deduct, and abduct innovation opportunities that align with value criteria and framed objectives.
8. Envision and visualize valuable potential as future user experience(s) in appropriate market context.
9. Invent and create iteratively with effective design skills, production knowledge, and perceptual literacy.
10. Decide with high levels of intelligence consistently throughout the innovation process.
11. Validate and /or develop appropriate proof of proposed concepts.
12. Propose innovation solutions as systems that grow with a strategy that evolves over time.
13. Define products and services as clear business models with market context.
14. Present and communicate at a professional level appropriate for executive leadership or potential investors.

15. Interact and function at a high level in organizations and teams esp. to manage alignment of expectations throughout innovation process.
16. Approach any design challenge or opportunity with drive and confidence.
17. Manage heavy workloads, complex organizational dynamics, and project challenges with aplomb.
18. Consistently create original, appropriate, aesthetically attractive, and desirable artifacts and user experiences.

10.4.2. Contents

The subjects that are more similar to the subject of Drawing Engineering are 3D development I, II and III. These subjects start by introducing the basics of form and surface development using prototyping methods with CAD and manual tools and process. The complexity of the prototypes and figures that are developed increases through the courses and it's topped in 3D development III where a high-performance racing vehicle in competitive teams has to be made, for example a formula E car.

This last project is an example of the mentality of the university, since the students not only have to design and develop the project but have to interact between themselves and with experts in the field of competitive racing to be able to build up a great project. Even if tutoring is always present to help the students with any problems they might encounter, the main objective of projects like this apart from developing the project is to be able to talk with experts on the field and start to see how the professional field works.