

Loughborough Design School



A taxonomy of design
representations to support
communication and
understanding during
new product development

ID Cards

ID Cards provide a **name**, **example** and **description** for the key design representations used by industrial/product designers during new product development (NPD).

They are grouped into four categories: **sketches**, **drawings**, **models** and **prototypes**.

Yellow tabs indicate the stage of NPD when the design representations are most commonly used (**concept design**, **design development**, **embodiment design** or **detail design**).

Red and blue tabs show if the design representation is used mainly to communicate **design information** (red), **technical information** (blue) or both, with the specific type of information being indicated on the tab itself. All of the names and descriptions can be applied to design representations that have been produced using methods that are digital, non-digital or a combination of both.

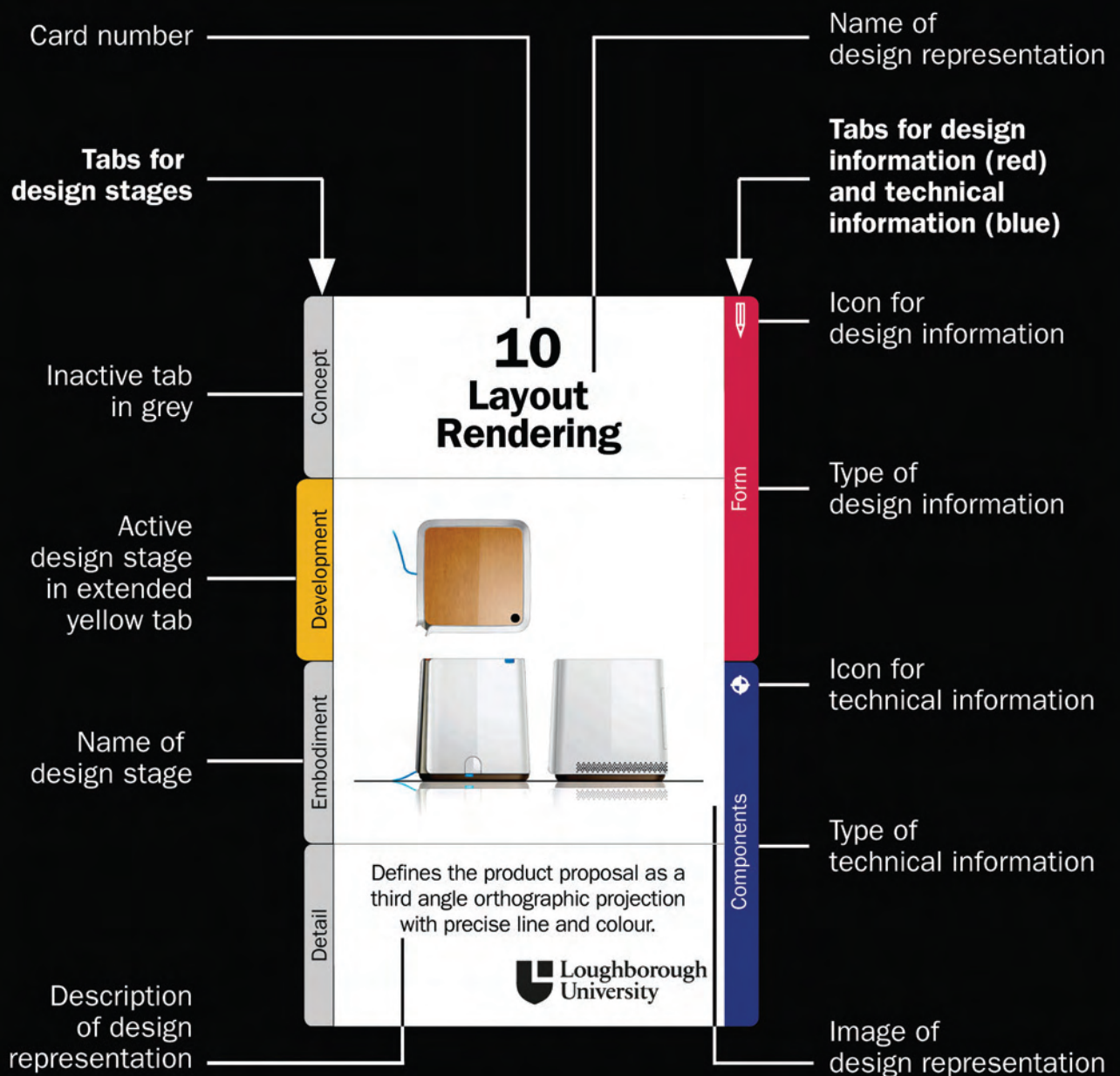
Credits

Dr Mark Evans: PhD supervisor, ID Cards concept, graphic design

Dr Eujin Pei: PhD researcher, ID Cards concept, artwork

Dr Ian Campbell: PhD supervisor

Card Layout



Background

ID Cards are one of the outcomes from a Loughborough Design School PhD undertaken by Dr Eujin Pei and supervised by Dr Mark Evans and Dr Ian Campbell. The aim of the research was to improve collaboration between industrial/product designers and engineering designers during NPD.

© Evans, M.A., and Pei, E., *ID Cards*,
Loughborough University 2010.
ISBN: 978 1 907382 35 2

Research Methods

Literature review, action research, surveys and observations were used to collect data during the development of the ID Cards. A central feature of the research methodology was a high degree of global engagement with educators and practitioners, with support being received from leading universities, consultancies and manufacturers.

Results

Research findings indicated a need to facilitate greater understanding of the language and methods used by industrial/product designers and engineering designers. The key design representations employed during NPD were identified and surveys undertaken to establish when they were used and for what types of information. This generated large amounts of data that was converted into a playing card based tool for use by designers. ID Cards have translated and modified key elements of the 114 double-side cards into a more portable and accessible format to support the education and practice of designers at all levels.

Further details on the PhD can be accessed at <http://hdl.handle.net/2134/5432>

Loughborough Design School would like to thank its industrial/product design students for contributing the 32 images used on the ID Cards and the IDSA for its on-going support.



Sketches

Preliminary, loose visual representations of design ideas that lack the detail of a more refined proposal.



Drawings

Formal representations to define design intent without ambiguity. More structured and controlled than sketches.



Models

Explore and define function, performance and appearance. Used to progress design development.



Prototypes

Communicate and verify the final design, facilitate customer evaluation and finalise performance/visual issues.

Concept

Concept Design

The most visually creative stage, employing techniques that facilitate speed and spontaneity.

Development

Design Development

Involves a process of selection and refinement to ensure that proposals are capable of meeting the product specification.

Embodiment

Embodiment Design

Creates a fixed layout by selecting the most suitable configuration and evaluating this against technical and commercial criteria.

Detail

Detail Design

Defines the production item through the specification of details such as materials, dimensions and assembly. Supports final testing before manufacture.

Areas of Concern

Features of the design that require investigation to help understand potential problem areas, particularly in terms of safety, use and manufacture.

Form

The exploration or specification of product appearance in terms of overall form, surfaces, proportion and scale.

Design Intent

How the components and features of a product combine to perform the required function.

Types of Design Information

Scenario of Use

Identifies how a product would be used in a projected sequence of events. May include relationships between the user, environment and other products.

Usability & Operation

How the product is used, including functional effectiveness, convenience and safety.

Visual Character

Supporting the generation of ideas with features that have reference to existing objects, products or living creatures.

Types of Design Information

Assembly

The systematic sequence of events required to bring components together to create the final product.

Components

Descriptions of the individual parts that combine to form the final product.

Construction

The detailed method for attaching individual components, including the use of adhesives, fasteners and fits.

Types of Technical Information

Dimensions

Specification through the use of a given unit of measurement, including angles and tolerances.

Materials

A specification for the metals, plastics, woods, textiles and other materials from which a product can be manufactured.

Performance

Assembly of static or moving parts, including electro/mechanical systems, that demonstrate capacity to perform a function.

Types of Technical Information

1
Idea Sketch


Concept

Development


Embodiment

Detail

Design Intent



Employed at a personal level to quickly externalise thoughts using simple line-work. Also known as a Thumbnail, Thinking or Napkin Sketch.



2
Study Sketch


Concept

Development


Embodiment

Detail

Form



Used to investigate appearance, proportion and scale in greater detail than an Idea Sketch. Often supported by the loose application of tone/colour.



3
Referential Sketch

Concept

Development

Embodiment

Detail

Visual Character



Used to record images of products, objects, living creatures or any relevant observations for future reference or as a metaphor.



4
Memory Sketch


Concept

Development

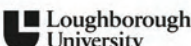
Embodiment

Detail

Scenario of Use



Helps expand thoughts during the design process using mind maps, notes and annotations.



5
Coded Sketch

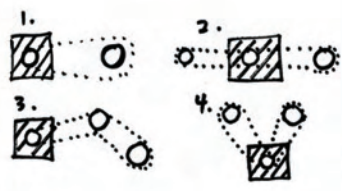
Concept

Development

Embodiment

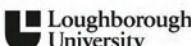
Detail

Components



Symbol: ○ gear belt ○
▨ motor

Informal coded representation that categorises information to demonstrate an underlying principle or scheme.



6
Information Sketch

Concept

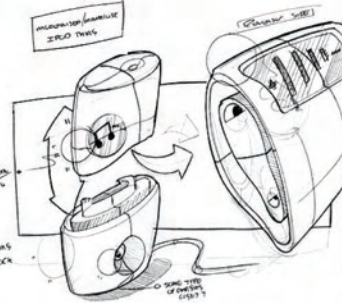
Development

Embodiment

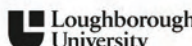
Detail

Design Intent

Construction




Quickly and effectively communicates features through the use of annotation and supporting graphics. Also known as an Explanatory or Talking Sketch.



Sketches



iD
CARDS



7
Sketch Rendering


Concept

Development

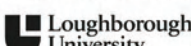
Embodiment

Detail

Form



Clearly defined proposal produced by controlled sketching and use of colour/tone to enhance detail and realism. Also known as a First Concept.



8
Prescriptive Sketch

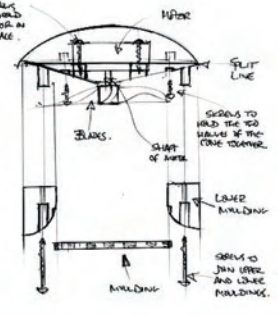
Concept

Development

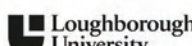
Embodiment

Detail

Components




Informal sketch for the exploration of technical details such as mechanisms, manufacturing, materials and dimensions.




Concept

9 Scenario & Storyboard

Development




Embodiment



Detail

Describes interaction between user and product, sometimes in an appropriate context.




Scenario of Use


Concept

10 Layout Rendering

Development

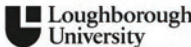


Embodiment



Detail

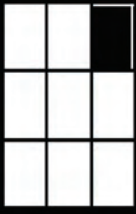

Defines the product proposal as a third angle or orthographic projection with precise line and colour.



Form

Components


Drawings

Concept

11 Presentation Rendering

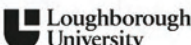
Development



Embodiment

Detail

Contains a high level of realism to fully define product appearance as a perspective view. Particularly useful for decision making by non-designers.

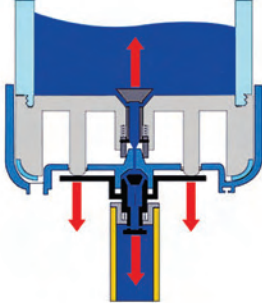


Form

Concept

12 Diagram

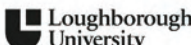
Development



Embodiment

Detail

Schematic representation of the operating principle or relationship between components. Also known as a Schematic or Diagrammatic Drawing.

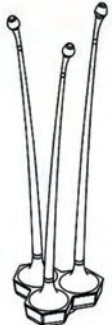


Components

Concept

13 Perspective Drawing

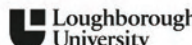
Development



Embodiment

Detail

Descriptive three-quarter view produced using a perspective drawing technique. Created using line only without the application of colour or tone.

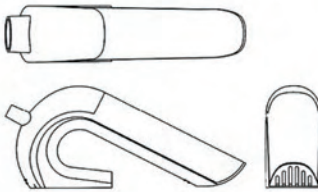


Form

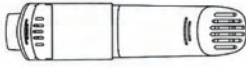
Concept

14 General Arrangement Drawing

Development

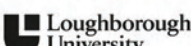


Embodiment



Detail

Exterior view of all components using line only and with sufficient detail to produce an Appearance Model if required. Usually drawn in third angle projection.

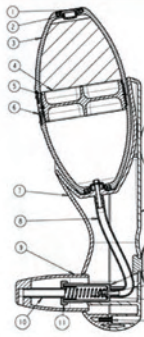


Components

Concept

15 Detail Drawing

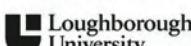
Development



Embodiment

Detail

Contains detail of components for the manufactured product. Also known as a Technical, Production or Construction Drawing.



Dimensions

Concept

16 Technical Illustration

Development



Embodiment

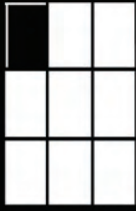
Detail

Communicates technical detail with a high degree of realism that is sometimes supported with symbols. Includes exploded views.



Components

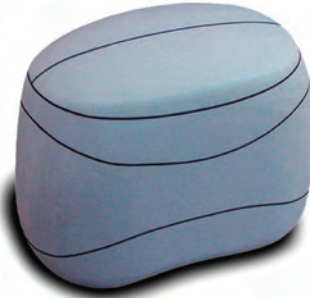
Models



Concept

17 Sketch Model

Development

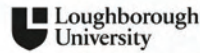


Form

Embodiment

Detail

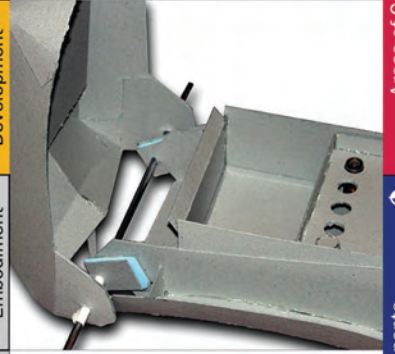
Informal, relatively low definition 3D model that captures the key characteristics of form. Also known as a Foam Model or 3D Sketch.



Concept

18 Design Development Model

Development

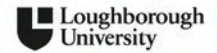


Areas of Concern

Embodiment

Detail

Simple mock-up used to explore and visualise the relationships between components, cavities, interfaces and structures. Usually produced using card.

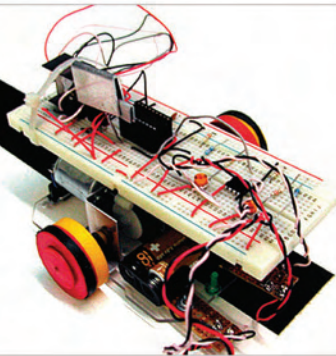


Components

Concept

19 Functional Model

Development



Embodiment

Detail

Captures the key functional features and underlying operating principles. Has limited or no association with the product's final appearance.



Performance

Concept

20 Operational Model

Development



Embodiment

Detail

Communicates how the product is used with the potential for ergonomic evaluation.



Usability & Operation

Concept

21 Appearance Model

Development



Embodiment

Detail

Accurate physical representation of product appearance. Also known as a Block Model as it tends not to contain any working parts.

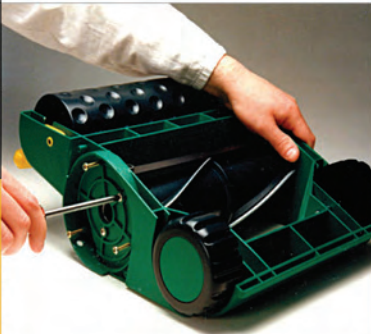


Form

Concept

22 Assembly Model

Development



Embodiment

Detail

Enables the evaluation and development of the methods and tools required to assemble product components.

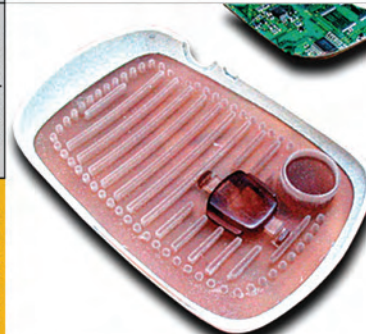


Assembly

Concept

23 Production Model

Development



Embodiment

Detail

Used to evaluate and develop the location and fit of individual components and sub-assemblies.



Construction

Concept

24 Service Model

Development



Embodiment

Detail

Supports the development and demonstration of how a product is serviced and maintained.




Assembly

Concept

25 Experimental Prototype

Development




Embodiment

Detail

Refined prototype that accurately models physical components to enable the collection of performance data for further development.

Performance



Concept

26 Alpha Prototype

Development



Embodiment

Detail

Brings together key elements of appearance and functionality for the first time. Uses or simulates production materials.

Construction



Concept

27 Beta Prototype

Development



Embodiment

Detail

A refined evolution of an Alpha Prototype used to evaluate on-going design changes in preparation for the final specification of all components.

Construction

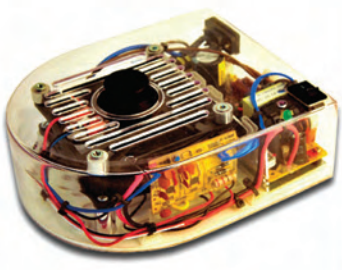
Usability & Operation



Concept

28 System Prototype

Development

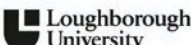


Embodiment

Detail

Integrates components specified for the production item without consideration of appearance. Used to evaluate electronic and mechanical performance.


Performance



Concept

29 Final Hardware Prototype

Development

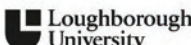


Embodiment

Detail

Developed from the System Prototype as a final representation of the product's functional elements.

Performance



Concept

30 Off-Tool Component

Development



Embodiment

Detail

Produced using the tooling and materials intended for production to enable the evaluation of material properties and appearance of components.


Materials



Concept

31 Appearance Prototype

Development



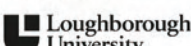
Embodiment

Detail

Highly detailed representation that combines functionality with exact product appearance. Uses or simulates production materials.

Performance

Design Intent



Concept

32 Pre-Production Prototype

Development



Embodiment

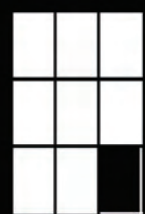

Detail

Final prototype produced using production components. Manufactured in small volumes for testing prior to full scale production.

Performance




Prototypes

Printed Cards




1 Idea Sketch




Employed at a personal level to quickly externalise thoughts using simple line-work. Also known as a Thumbnail, Thinking or Sketch Sketch.

2 Study Sketch




Used to investigate appearance, proportion and scale in greater detail than an idea sketch. Often supported by the loose application of tone/colour.

3 Referential Sketch



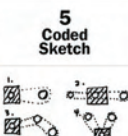
Used to record images of products, objects, being creators or being relevant observations for future reference or as an illustration.

4 Memory Sketch



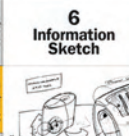
Helps expand thoughts during the design process using simple marks, notes and annotations.

5 Coded Sketch




Informal coded representation that categorises information to demonstrate an underlying principle or scheme.

6 Information Sketch




Quickly and effectively communicates features through the use of annotation and supporting graphics. Also known as an Explainer or Explainer Sketch.

7 Sketch Rendering




Clearly defined proposal produced by controlled sketching and use of colour to enhance detail and realism. Also known as a First Concept.

8 Prescriptive Sketch




Informal sketch for the exploration of technical details such as mechanisms, manufacturing, materials and dimensions.

9 Scenario & Storyboard




Describes interaction between user and product, sometimes in an appropriate context.

10 Layout Rendering




Defines the product proposal as a best angle orthographic projection with precise line and colour.

11 Presentation Rendering



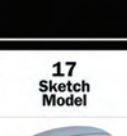
Contains a high level of realism to fully define product appearance as a perspective view. Particularly useful for decision making or non-designers.

12 Diagram




Schematic representation of the operating principle or relationship between components. Also known as a Schematic or Engineering Drawing.

13 Perspective Drawing




Descriptive three-quarter view produced using a perspective drawing technique. Created using line only without the application of colour or tone.

14 General Arrangement Drawing




Exterior view of all components using line only and with sufficient detail to produce an Appearance Model if required. Usually drawn in third angle projection.

15 Detail Drawing



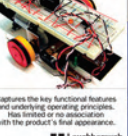
Contains detail of components for the manufactured product. Also known as a Technical, Production or Construction Drawing.

16 Technical Illustration




Communicates technical detail with a high degree of realism that is sometimes augmented with textures. Includes exploded views.

17 Sketch Model




Informal, relatively low definition 3D model that captures the key characteristics of form. Also known as a Foam Model or 3D Sketch.

18 Design Development Model




Simple mock-up used to explore and visualise the relationships between components, cavities, inter-faces and structures. Usually produced using card.

19 Functional Model




Captures the key functional features and underlying operating principles. Has limited or no association with the product's final appearance.

20 Operational Model




Communicates how the product is used with the potential for ergonomic evaluation.

21 Appearance Model



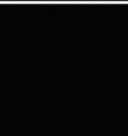
Accurate physical representation of product appearance. Also known as a Block Model as it tends not to contain any working parts.

22 Assembly Model



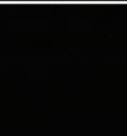
Enables the evaluation and development of the methods and tools required to assemble product components.

23 Production Model



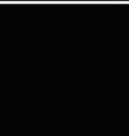
Used to evaluate and develop the location and fit of individual components and sub-assemblies.

24 Service Model



Supports the development and demonstration of how a product is serviced and maintained.

25 Experimental Prototype



Refined prototype that accurately models physical components to enable the collection of performance data for further development.

26 Alpha Prototype

Brings together key elements of appearance and functionality for the first time. Uses or simulates production materials.

27 Beta Prototype

A refined evolution of an Alpha Prototype used for production to enable changes in preparation for the final specification of components.

28 System Prototype

Integrates components specified for the production item without consideration of appearance. Used to evaluate electronic and mechanical performance.

29 Final Hardware Prototype

Developed from the System Prototype as a final representation of the product's functional elements.

30 Off-Tool Component

Produced using the tooling and materials intended for production to enable the evaluation of material properties and appearance of components.

31 Appearance Prototype

Highly detailed representation that combines functionality with exact product appearance. Uses or simulates production materials.

32 Pre-Production Prototype

Final prototype produced using production components. Manufactured in full volumes for testing prior to full scale production.

19 Functional Model



Captures the key functional features and underlying operating principles. Has limited or no association with the product's final appearance.

20 Operational Model



Communicates how the product is used with the potential for ergonomic evaluation.

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33 Design Practice Research

Loughborough Design School

The 20 full-time academic staff and 15 PhD researchers of the Design Practice Research Group have a world-leading reputation for fundamental and applied research in:

- Digital modelling
- Emerging technologies
- Design process improvement
- Data collection through practice
- User-based product development

Collaborating organisations include Jaguar Land Rover, Procter and Gamble, NIJ, Hewlett Packard, BBC, Parametric Technology Corporation, Motorola, Alstom Design Foundation, Ford Motor Company and Research Councils UK.

For further information on the research activities of the Design Practice Research Group, please visit the Design School website or contact the Design School or Dr Mark Evans (M.A.E@lboro.ac.uk).