

**ME 4182**

**Understanding People, Products and Context:  
Industrial Design Lite for Engineering**

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Georgia Tech – Spring 2019

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# Agenda

## Special Topic: Basic Industrial Design (ID) Concepts

*basic concepts you need to know to communicate with industrial designers*

- Setting the Stage
- Concepts
- Toolkits and Techniques
- Q&A

# Setting the Stage

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- Though engineering sciences are often exceptional tools for optimizing subsystems of products, engineers often fail to ask broader questions and challenge design assumptions.
- Design teams need to better understand people, product use, and human context in order to better arrive at “black box” design constraints.
- Industrial Designers, working with business groups (marketing and product planning) conceptualize the product, early in its development. The results are often handed off to engineering.

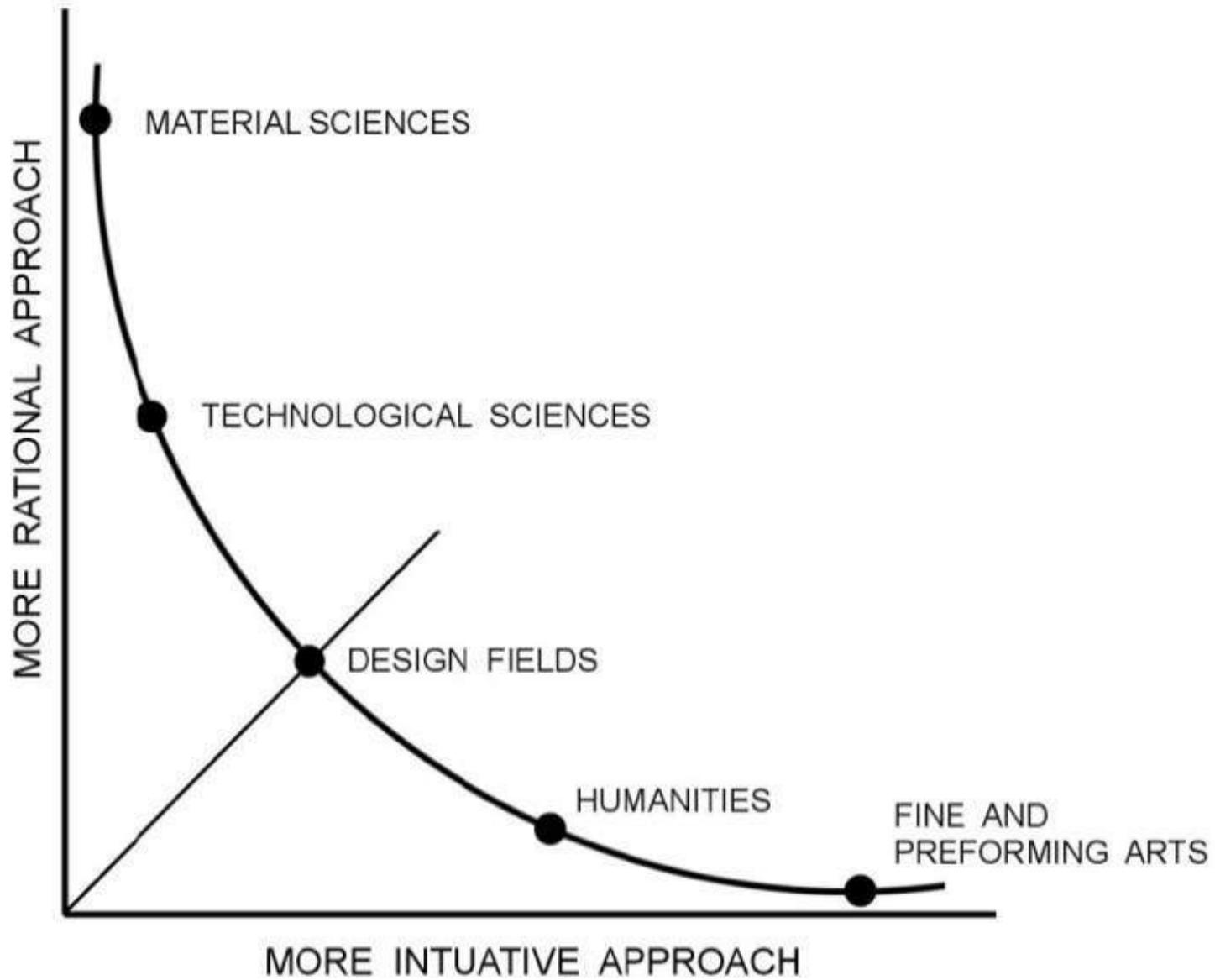


Form follows function

Form communicates function

Form enables function

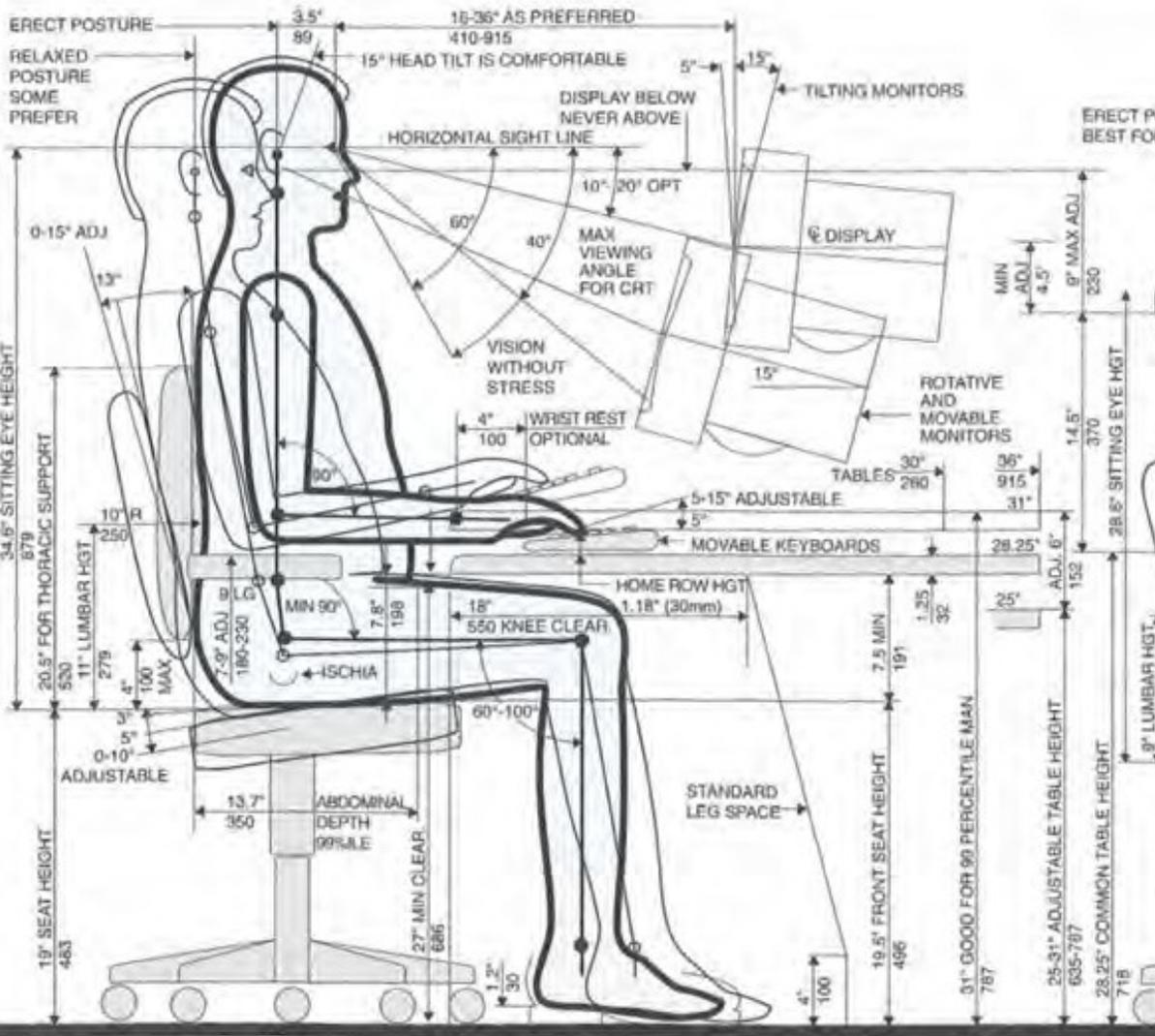
Form follows emotion



Concepts

Between science and art

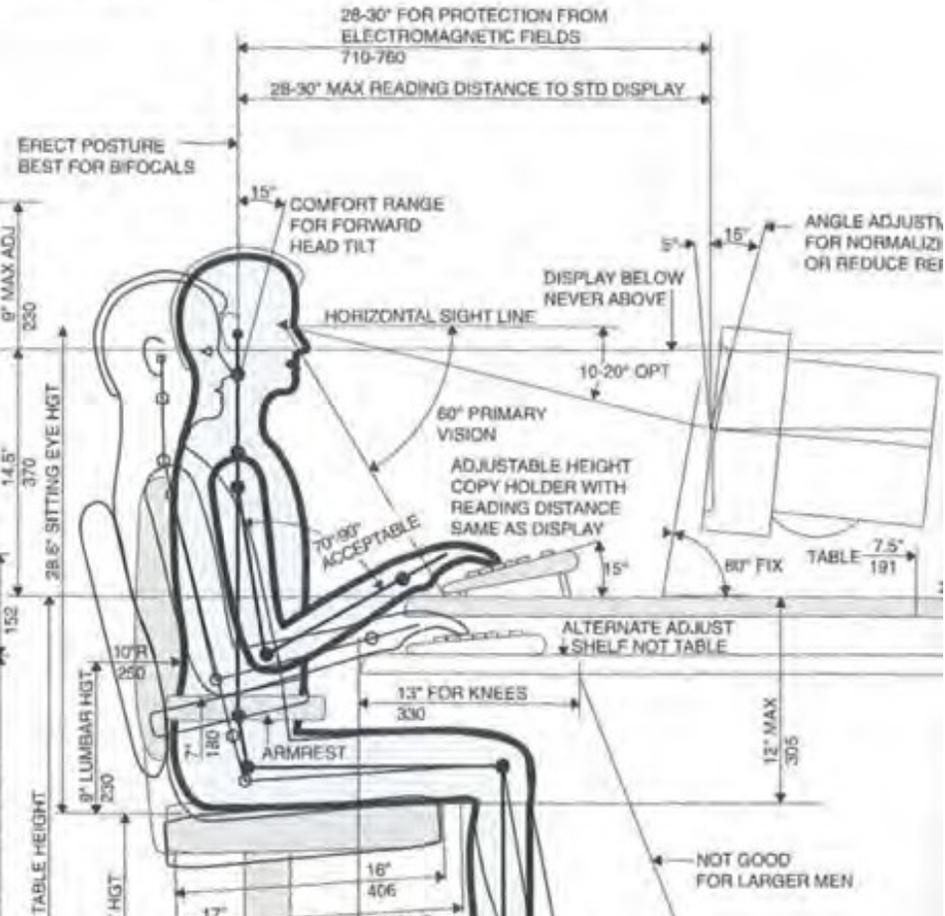
## LARGE MAN 99 PERCENTILE US POPULATION



FOR COMFORT, SAFETY AND PROTECTION USE ADJUSTABLE TABLE HEIGHTS.  
FOR MEN ONLY ADJUST 25"-31". ALTERNATE: USE COMPROMISE FIXED HEIGHT  
635-787

TO ACCOMMODATE ALL ADULTS (MEN / WOMEN)  
PROVIDE ADJUSTABLE TABLES 21"-31"  
641-780

## SMALL MAN 1 PERCENTILE US POPULATION



## Analogue to Engineering

- ★ Engineering : Applied Physics
- ★ Industrial Design: Applied Social Sciences

- Cognitive Psychology (aesthetics)
- Anthropology (human factors / ethnography)
- Sociology (context / narrative)

# Concepts

# Design Decision

- How do we consider the physical and cognitive capabilities of our end users with design?

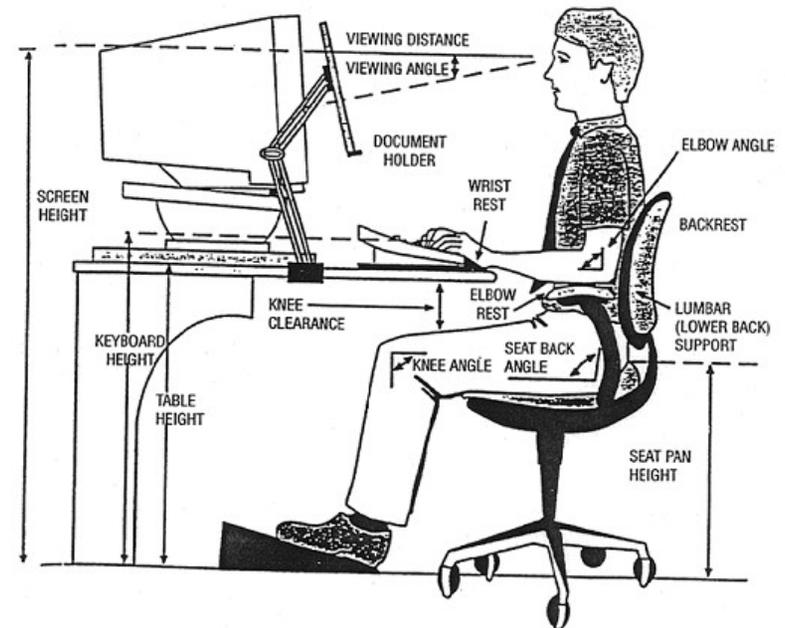
# Human Factors/ergonomics

Designing for the interaction between the artifact/system and human beings

- Physical
- Cognitive
- Organizational

# Physical ergonomics

- How to design for the comfort and functioning of the human body
- Anthropometrics – measuring humans
- Physiology – how the body functions
- Bio Mechanics – study of the structure of the body from a mechanical view – forces and actions



[www.megep.meb.gov.tr](http://www.megep.meb.gov.tr)

# Cognitive ergonomics

- Mental processes as they effect interaction with products/systems
- Perception
- Memory
- Reasoning
- Motor Response



# When Cognitive Ergonomics Go Wrong

- Cognitive “overload”
- Attention tunneling
  
- Warning systems
- Information systems
- Alarm systems
- User interfaces....

# Organizational Ergonomics

- Optimization of systems involving humans
  - Structures
  - Policies
  - Procedures
  - Communication
  - Resource management
  - Community



[www.centerhfe.com](http://www.centerhfe.com)

# Human Factors Methods

- **Activity mapping/task analysis** – watching how humans go about their lives/tasks
- **Iterative design** – prototype and test with humans for fit/comfort/understanding
- **Cognitive walkthrough** – putting yourself in the end user's shoes to experience/evaluate the design
- **Personas** – design with an intended user in mind – define that user with concrete characteristics that most users would share
- **Scenarios** – develop problem situations that could be addressed or solved with design solutions – take the form of a narrative

# Human Factors Resources

- [www.osha.gov/SLTC/ergonomics/](http://www.osha.gov/SLTC/ergonomics/)
- [www.cdc.gov/niosh/topics/ergonomics/](http://www.cdc.gov/niosh/topics/ergonomics/)
- [en.wikipedia.org/wiki/](http://en.wikipedia.org/wiki/)  
[Human factors and ergonomics](http://en.wikipedia.org/wiki/Human_factors_and_ergonomics)
- [www.iea.cc/whats/index.html](http://www.iea.cc/whats/index.html)
- [www.hfes.org//Web/Default.aspx](http://www.hfes.org//Web/Default.aspx)
- [www.ergonomics.org.uk](http://www.ergonomics.org.uk)
- [Liberty Mutual](#)

Understand

Express

Test

Cycle

Empathy

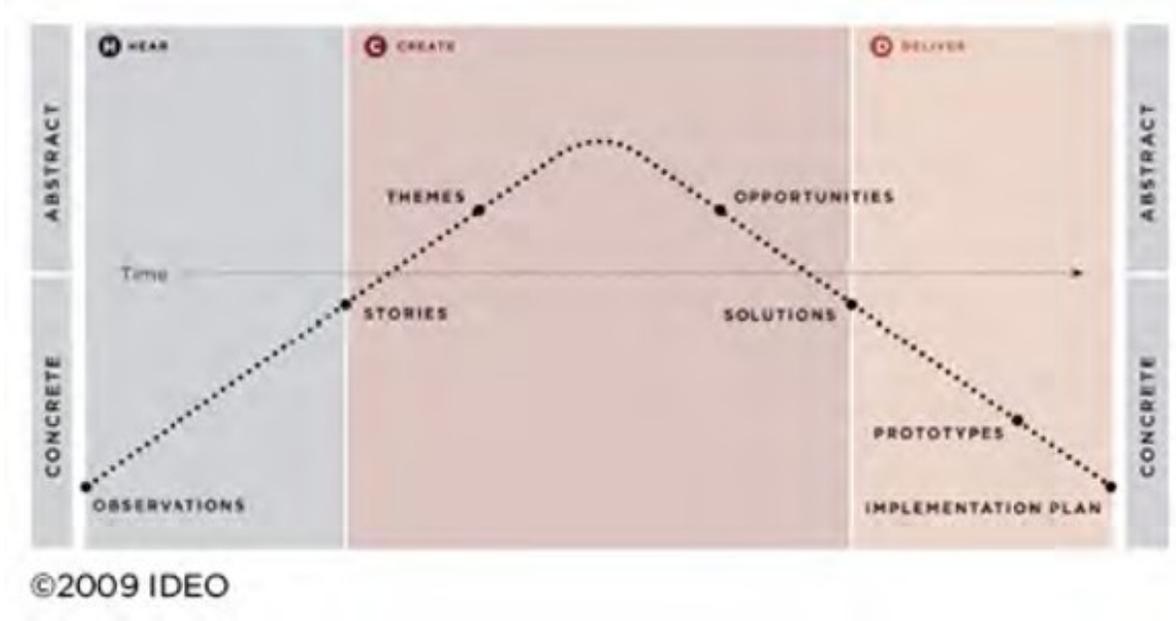
Creativity

Execution

Hear

Create

Deliver

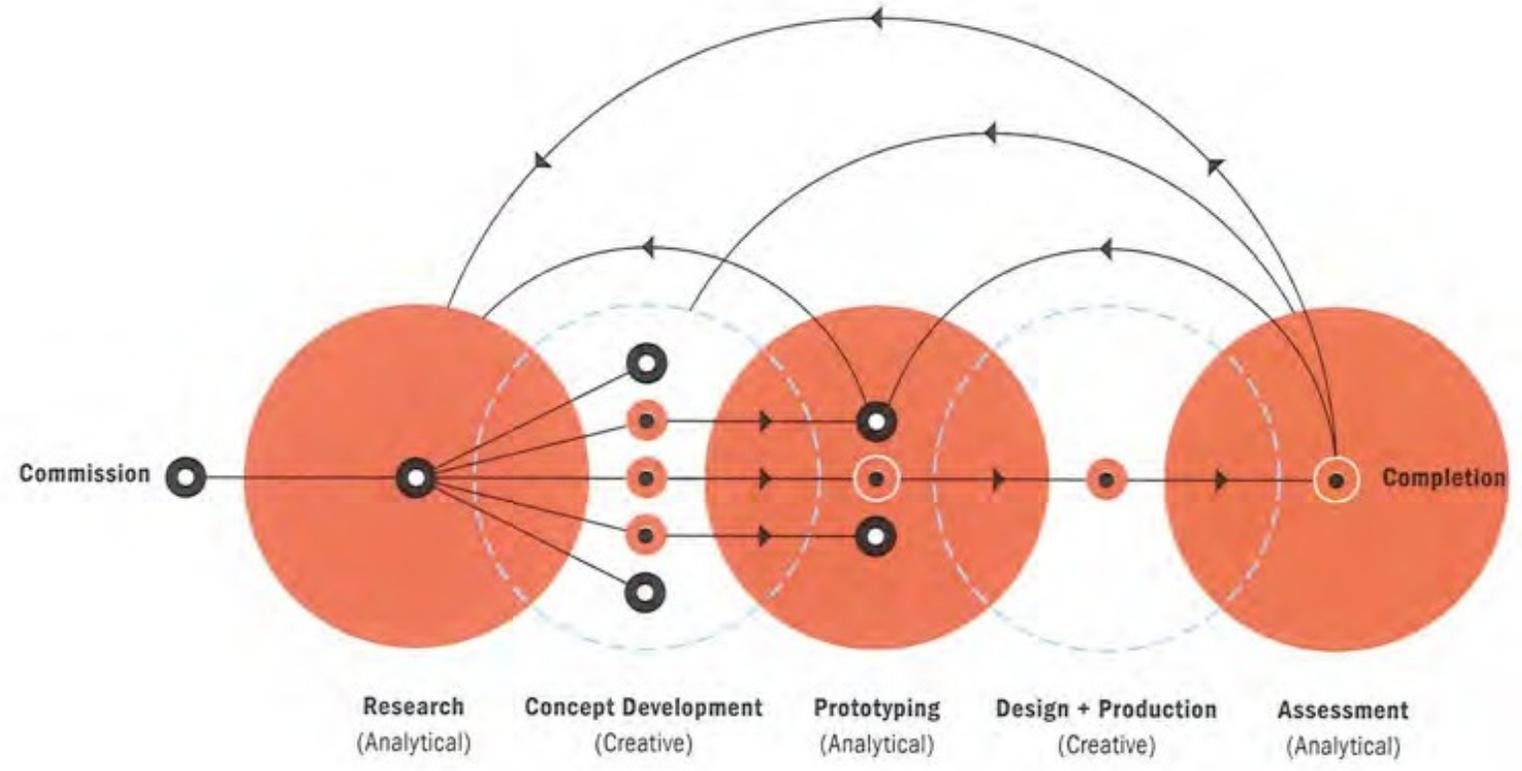
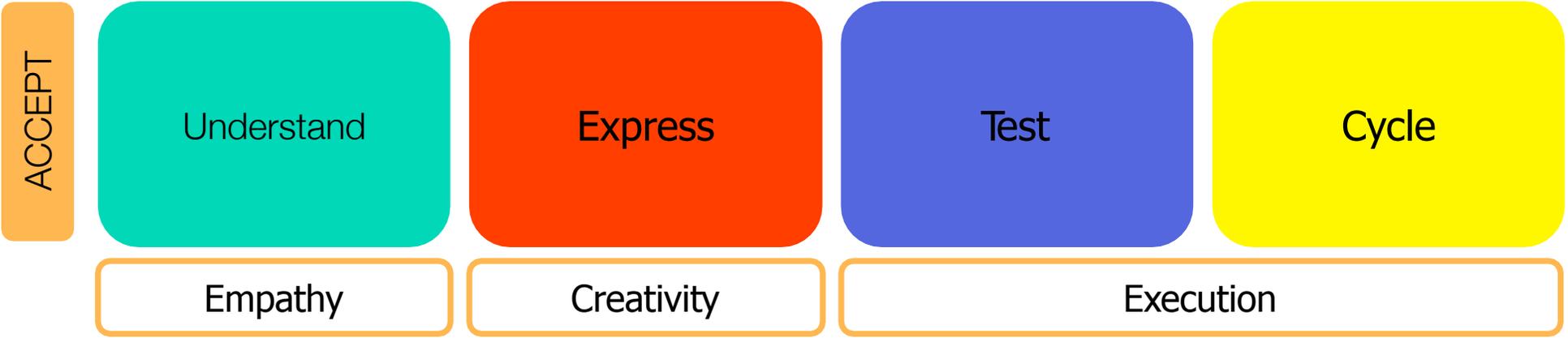


Both Engineering and ID share the design process:

- Explore & Understand
- Express a Design (hypothesis)
- Test the Prototype
- Refine and Iterate

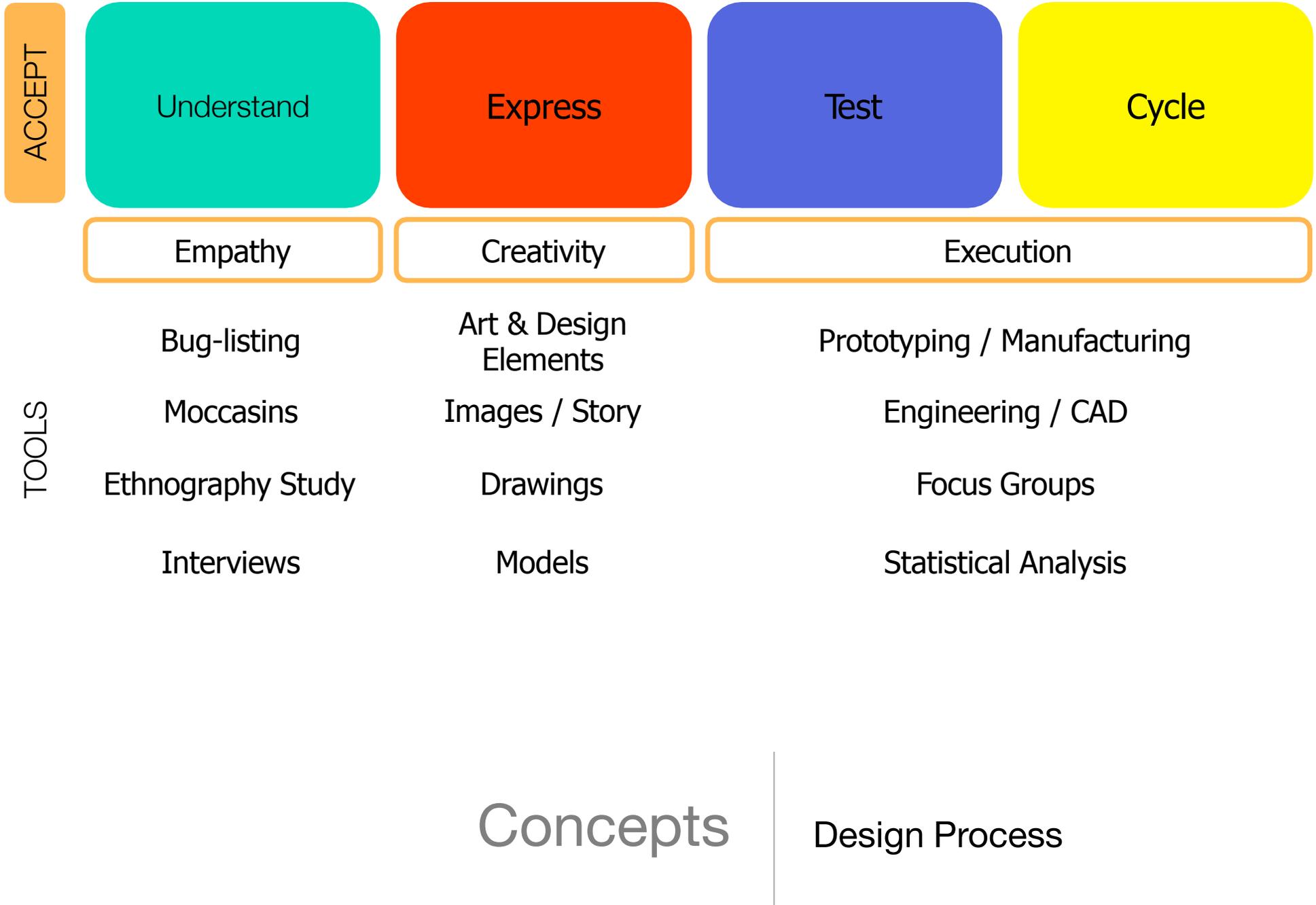
Concepts

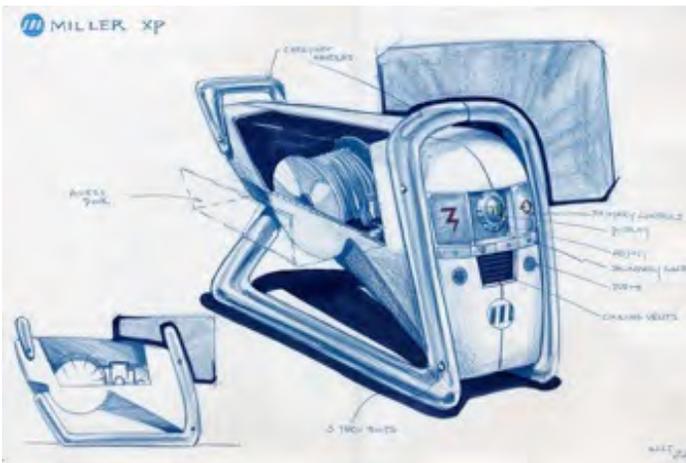
Design Process



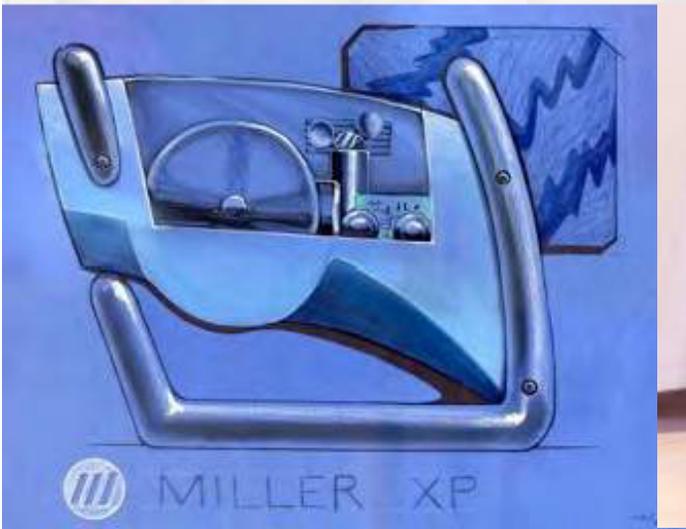
Concepts

Design Process





PCB size 37mmx29mm

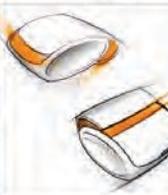
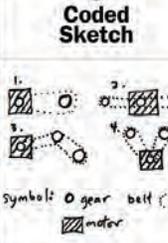
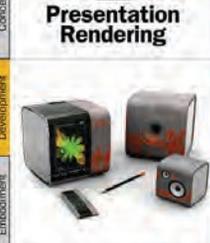
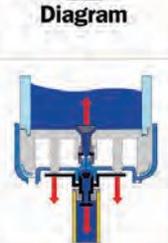
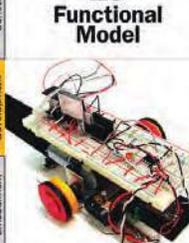
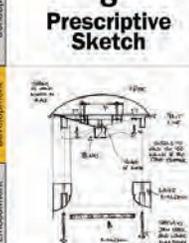


# Concepts

## Product Visualization

Several Techniques to quickly prototype product concepts

- Sketches
- Paper Prototypes / Foam Models
- Appearance Models
- Functional Models
- Computer 3D Modeling

<p><b>1</b> <b>Idea Sketch</b></p>  <p>Used at a personal level to quickly capture thoughts using simple lines. Also known as a Thumbnail, Napkin Sketch, or Brain Sketch.</p> <p>Loughborough University</p>	<p><b>2</b> <b>Study Sketch</b></p>  <p>Used to investigate appearance, proportion and scale in greater detail than an Idea Sketch. Often supported by the loose application of tone/colour.</p> <p>Loughborough University</p>	<p><b>3</b> <b>Referential Sketch</b></p>  <p>Used to record images of products, objects, living creatures or any relevant observations for future reference or as a metaphor.</p> <p>Loughborough University</p>	<p><b>9</b> <b>Scenario &amp; Storyboard</b></p>  <p>Describes interaction between user and product, sometimes in an appropriate context.</p> <p>Loughborough University</p>	<p><b>10</b> <b>Layout Rendering</b></p>  <p>Defines the product proposal as a third angle or orthographic projection with precise line and colour.</p> <p>Loughborough University</p>	<p><b>Drawings</b></p>  <p>iD CARDS</p>	<p><b>Models</b></p>  <p>iD CARDS</p>	<p><b>17</b> <b>Sketch Model</b></p>  <p>Informal, relatively low definition 3D model that captures the key characteristics of form. Also known as a Foam Model or 3D Sketch.</p> <p>Loughborough University</p>
<p><b>4</b> <b>Memory Sketch</b></p>  <p>Expand thoughts during the process using mind maps, notes and annotations.</p> <p>Loughborough University</p>	<p><b>5</b> <b>Coded Sketch</b></p>  <p>Informal coded representation that categorises information to demonstrate an underlying principle or scheme.</p> <p>Loughborough University</p>	<p><b>6</b> <b>Information Sketch</b></p>  <p>Quickly and effectively communicates features through the use of annotation and supporting graphics. Also known as an Explanatory or Talking Sketch.</p> <p>Loughborough University</p>	<p><b>11</b> <b>Presentation Rendering</b></p>  <p>Contains a high level of realism to fully define product appearance as a perspective view. Particularly useful for decision making by non-designers.</p> <p>Loughborough University</p>	<p><b>12</b> <b>Diagram</b></p>  <p>Schematic representation of the operating principle or relationship between components. Also known as a Schematic or Diagrammatic Drawing.</p> <p>Loughborough University</p>	<p><b>13</b> <b>Perspective Drawing</b></p>  <p>Descriptive three-quarter view produced using a perspective drawing technique. Created using line only without the application of colour or tone.</p> <p>Loughborough University</p>	<p><b>19</b> <b>Functional Model</b></p>  <p>Captures the key functional features and underlying operating principles. Has limited or no association with the product's final appearance.</p> <p>Loughborough University</p>	<p><b>20</b> <b>Operational Model</b></p>  <p>Communicates how the product is used with the potential for ergonomic evaluation.</p> <p>Loughborough University</p>
<p><b>Drawings</b></p>  <p>iD CARDS</p>	<p><b>7</b> <b>Sketch Rendering</b></p>  <p>Clearly defined proposal produced by controlled sketching and use of colour/tone to enhance detail and realism. Also known as a First Concept.</p> <p>Loughborough University</p>	<p><b>8</b> <b>Prescriptive Sketch</b></p>  <p>Informal sketch for the exploration of technical details such as mechanisms, manufacturing, materials and dimensions.</p> <p>Loughborough University</p>	<p><b>14</b> <b>General Arrangement Drawing</b></p>  <p>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.</p> <p>Loughborough University</p>	<p><b>15</b> <b>Detail Drawing</b></p>  <p>Contains detail of components for the manufactured product. Also known as a Technical, Production or Construction Drawing.</p> <p>Loughborough University</p>	<p><b>16</b> <b>Technical Illustration</b></p>  <p>Communicates technical detail with a high degree of realism that is sometimes supported with symbols. Includes exploded views.</p> <p>Loughborough University</p>	<p><b>22</b> <b>Assembly Model</b></p>  <p>Enables the evaluation and development of the methods and tools required to assemble product components.</p> <p>Loughborough University</p>	<p><b>23</b> <b>Production Model</b></p>  <p>Used to evaluate and develop the location and fit of individual components and sub-assemblies.</p> <p>Loughborough University</p>

Concepts

Visual Communication

# Concepts

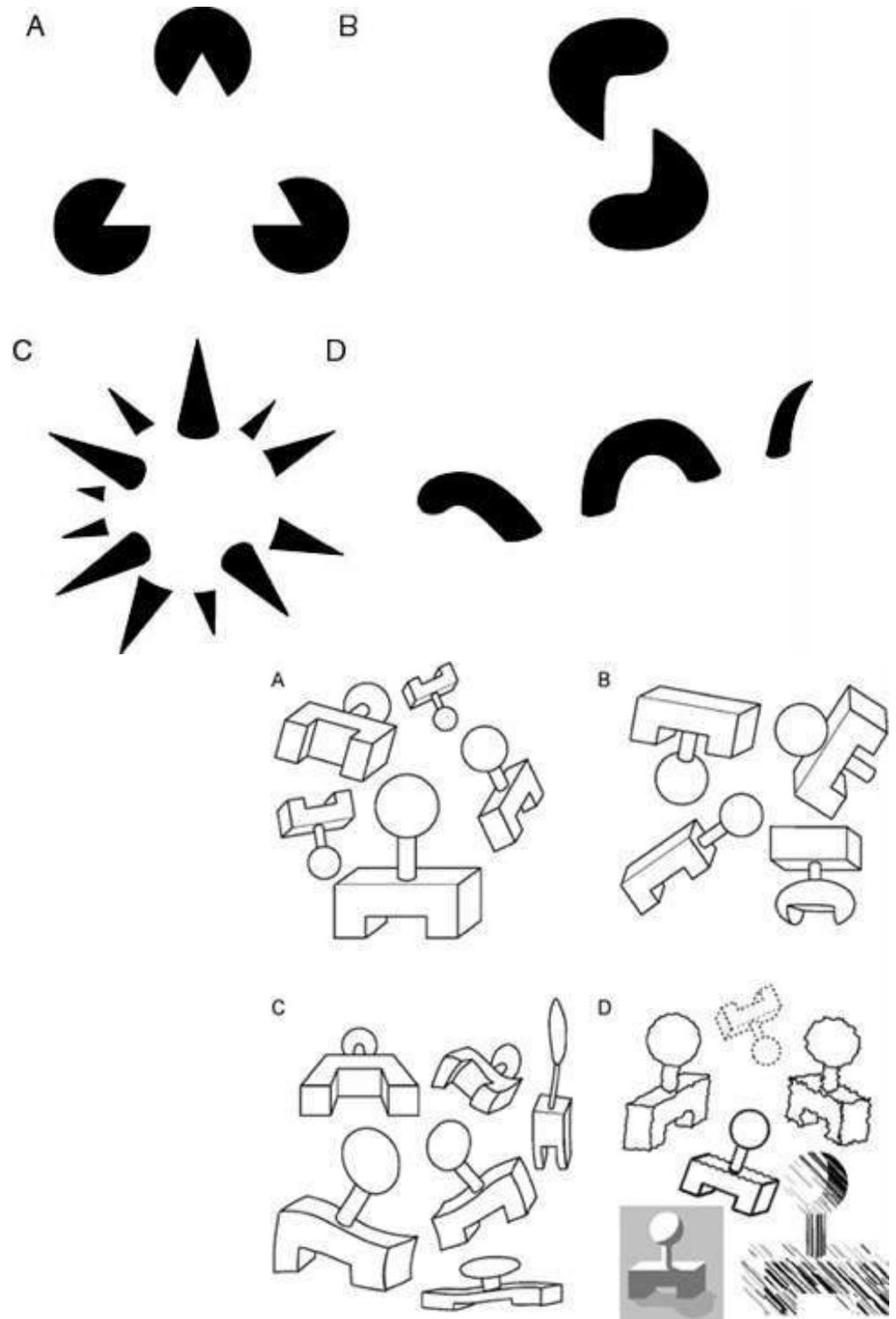
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## ••• Gestalt Principles:

early 19th cent. Cognitive Psychology

★ *is a theory of mind and brain of the Berlin School*

- the brain is holistic, parallel and analog with self organizing tendencies
- based on theories by Von Goethe, Hume, Kant, and Ernst Mach
- has formed the basis of further research into the perception of patterns and objects and of research into behavior, thinking, and problem solving

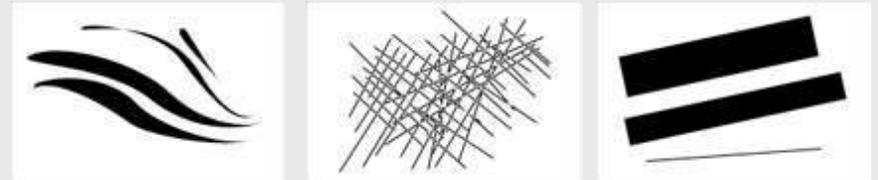


# Toolkits and Techniques: Elements of Art

- LINE
  - **Line can be considered in two ways. The linear marks made with a pen or brush or the edge created when two shapes meet.**
    - Horizontal - structure or calm
    - Vertical - reverence or balance
    - Diagonal and/or Zigzag- dynamic, movement
    - Curved - soft, organic
    - Line Weight as well as Line character
  
- SHAPE
  - **A shape is a self contained defined area, which are comprised of lines or edges. A positive shape in a design automatically creates a negative shape.**
    - Two dimensional - Flat
    - Geometric vs. Organic
    - Positive Shape vs. Negative Shape



Ben Shahn (Lithuanian) 1889-1968, Supermarket, serigraph



Joan Miro (Spanish) 1893-1983, The Policeman, Oil on canvas

# Toolkits and Techniques: Elements of Art

- FORM
  - **Form refers to three-dimensional shapes that have length, width and depth.**
    - Three dimensional - Volume (in sculpture) or the illusion of volume (in 2D work)
    - Full Round
    - Bas Relief
    - Shading: Light / Shadow
  
- SPACE
  - **Defined and determined by shapes and forms. Positive space is where shapes and forms exist; negative space is the empty space around shapes and forms.**
    - Collection of single or multiple shapes / forms
    - Positive Space: the object(s) itself aka the subject
    - Negative Space: the environment aka the ground



Michelangelo Buonoratti (Italian )  
1475-1564  
David, Marble sculpture



Sandy Skoglund (American) b.1946,  
Radioactive Cats, 1980, Chicken wire  
and plaster cats, furniture, live  
models



Henry Moore, (British) 1895-1986  
Reclining Figure, Elmwood,



Salvador Dali (Spanish) 1904-1989  
The Deterioration of The Persistence Of  
Memory, Oil on wood

# Toolkits and Techniques:

## Elements of Art

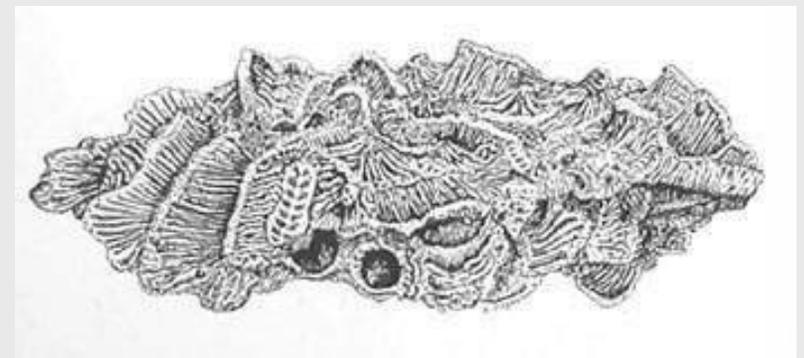
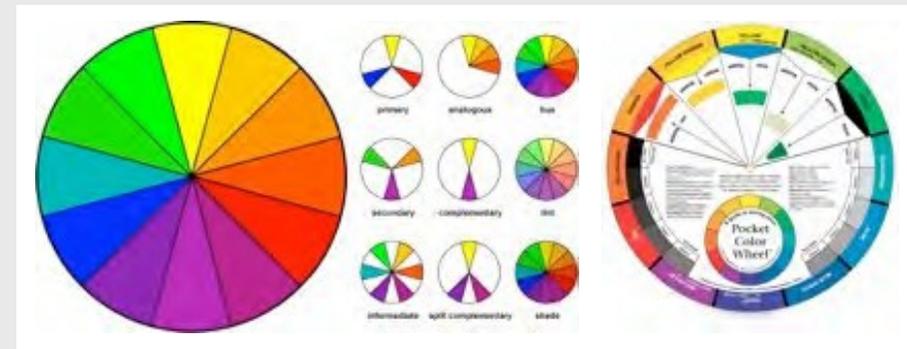
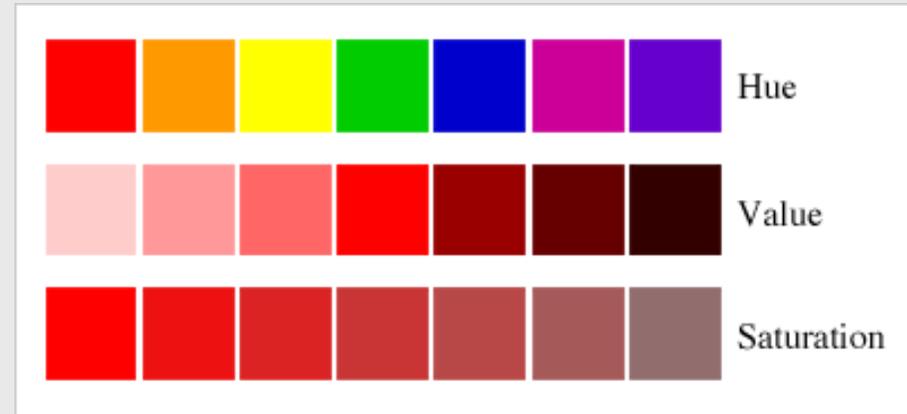
- COLOR

- **Color is produced when light strikes an object and reflects back in our eyes.**

- **Hue:** Where the color is positioned on the color wheel. Terms such as red, blue-green, and mauve all define the hue of a given color.
- **Value:** The general lightness or darkness of a color. How close to black or white a given color is.
- **Saturation:** The intensity, or level of chroma, of a color. The more gray a color has in it, the less chroma it has.

- TEXTURE

- refers to the surface quality or "feel" of an object - smooth, rough, soft, etc.
- Textures may be actual (felt with touch - tactile) or implied (suggested by the way an artist has created the work of art -visual)



Shanon Fitzpatrick, 11th Grade, Coral Study , Pen and Ink

# Concepts

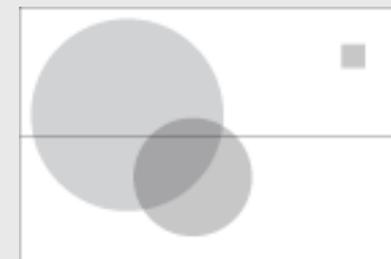
## Visual Hierarchy and Language

- Definition
  - **is the order in which the human eye perceives what it sees. This order is created by the visual contrast between forms in a field of perception. Objects with highest contrast to their surroundings are perceived first.**
    - Color
    - Size
    - Alignment
    - Character
- Basis
  - **Based on 20th century German Gestalt psychological theory**
    - innate in the human brain
    - to “structure individual elements, shapes or forms into a coherent, organized whole.”
    - Designers attempt to control visual hierarchy to guide the eye to information in a specific order for a specific purpose.



# Toolkits and Techniques: Principles of Design

- RHYTHM (MOVEMENT)
  - **is the repetition or alternation of elements, often with defined intervals between them. Rhythm can create a sense of movement, and can establish pattern and texture. There are many different kinds of rhythm, often defined by the feeling it evokes when looking at it.**
    - Regular: A regular rhythm occurs when the intervals between the elements, and often the elements themselves, are similar in size or length.
    - Flowing: A flowing rhythm gives a sense of movement, and is often more organic in nature.
    - Progressive: A progressive rhythm shows a sequence of forms through a progression of steps.
- BALANCE
  - **is the arrangement of the objects in a given design as it relates to their visual weight within a composition. Balance usually comes in two forms: symmetrical and asymmetrical.**
    - Symmetrical balance occurs when the weight of a composition is evenly distributed around a central vertical or horizontal axis or radially from a central point.
    - Asymmetrical balance occurs when the weight of a composition is not evenly distributed around a central axis or point.



# Toolkits and Techniques:

## Principles of Design

- PROPORTION

- is the comparison of dimensions or distribution of forms. It is the relationship in scale between one element and another, or between a whole object and one of its parts.

- Inherent
- Comparative
- Overall

- EMPHASIS or DOMINANCE

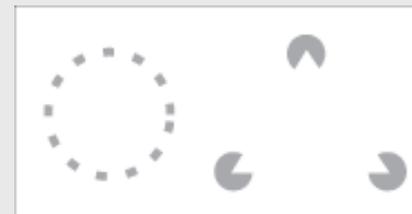
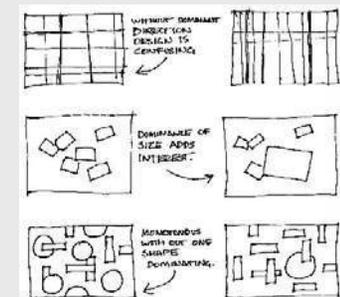
- determines the visual weight of a composition, establishes space and perspective, and often resolves where the eye goes first when looking at a design.

- Through the various elements and principles: shape, line, rhythm etc.
- Focus/depth of field pushes/pull your attention/the eye

- HARMONY or UNITY

- describes the relationship between the individual parts and the whole of a composition. Closure

- Continuance
- Similarity, Proximity and Alignment

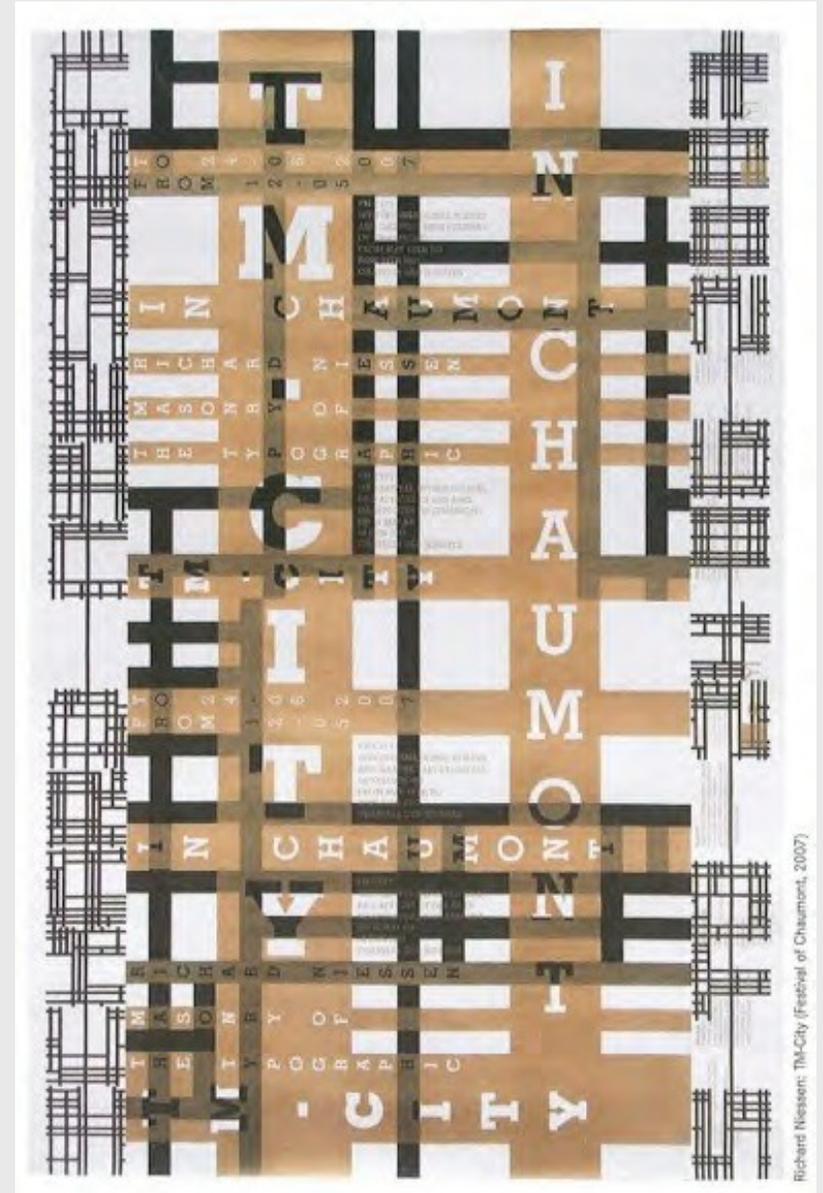


# Toolkits and Techniques:

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## Grids

- Definition
  - a series of lines (usually horizontal and vertical) that seek to define a space / page in order to better organize visual elements (e.g., text, images)
    - typographic grids for page layout
    - character lines for 3d sculpture / industrial design
- Considerations
  - **manifestation of your visual hierarchy**
    - use all Gestalt principles: i.e. Art Elements / Principles of Design
      - closure, similarity, proximity, color, size etc.
      - consider organization, balance, emphasis (dominant, subdominant subordinate etc)
    - cultural : US: left to right, top to bottom  
Asia: top to bottom, right to left



# Grids



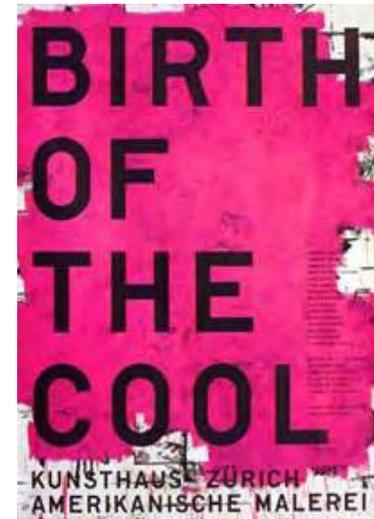
Designer unknown



Medea M, for Opernhaus, designed by Ruedi Rüegg, 1972



Atembogen, for Baltis und Rüegg, designed by Hug + Söhne, 1979



Birth of the Cool, designed by Cornel Windlin, 1997



Plakate Grafik Design, by Georg Staehelin, 1999

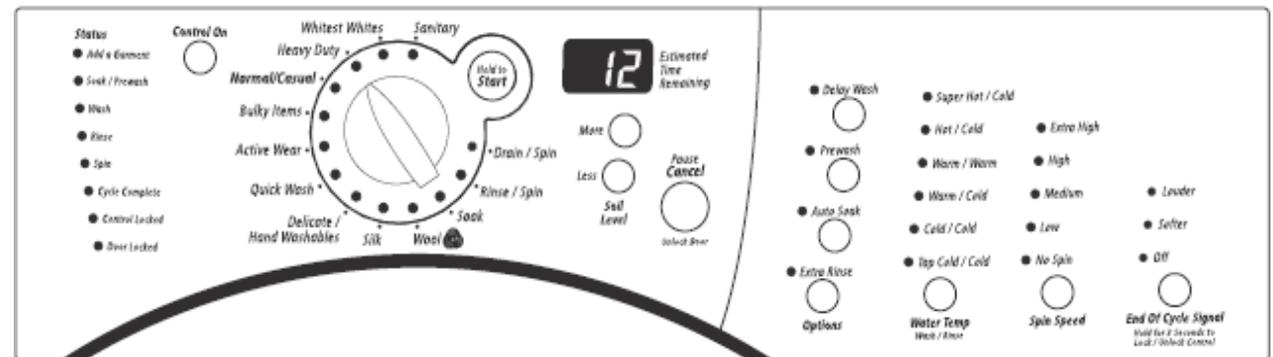


Designer unknown

Examples



## WASHER USE



Application

Principles of design

# Concepts

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## Materials and Manufacture

*Understanding the cognitive implication and perception of materials wrt aesthetics*

- Color Choice and Materials
- Surface Feeling / Texture
- Sustainability and Environmental Impact
- Aesthetic Consistency
- Quality Assurance
- Manufacturing Processes



# Concepts

## Systems + Visual Language



- Definition
  - **visual language is a system of communicating using visual elements**
    - utilizes same concepts for visual hierarchy (color, size, shape etc), but orders the weighting of the hierarchy.
    - Gauges the use of contrast relative to multiple applications
- Considerations
- used effectively, systems can retain a consistent aesthetic, tone or meaning
- used often in branding and marketing materials
- can establish visual, graphic rules whereby further variants of a design are constructed



# Systems - Visual Language



# Concepts

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## Ethnography: User Observation

- the rigorous study of the routine daily lives of a group of people

## Key Attributes

- People make sense
- Accessing implicit and explicit information
- Multiple Perspectives
- Natural Environment

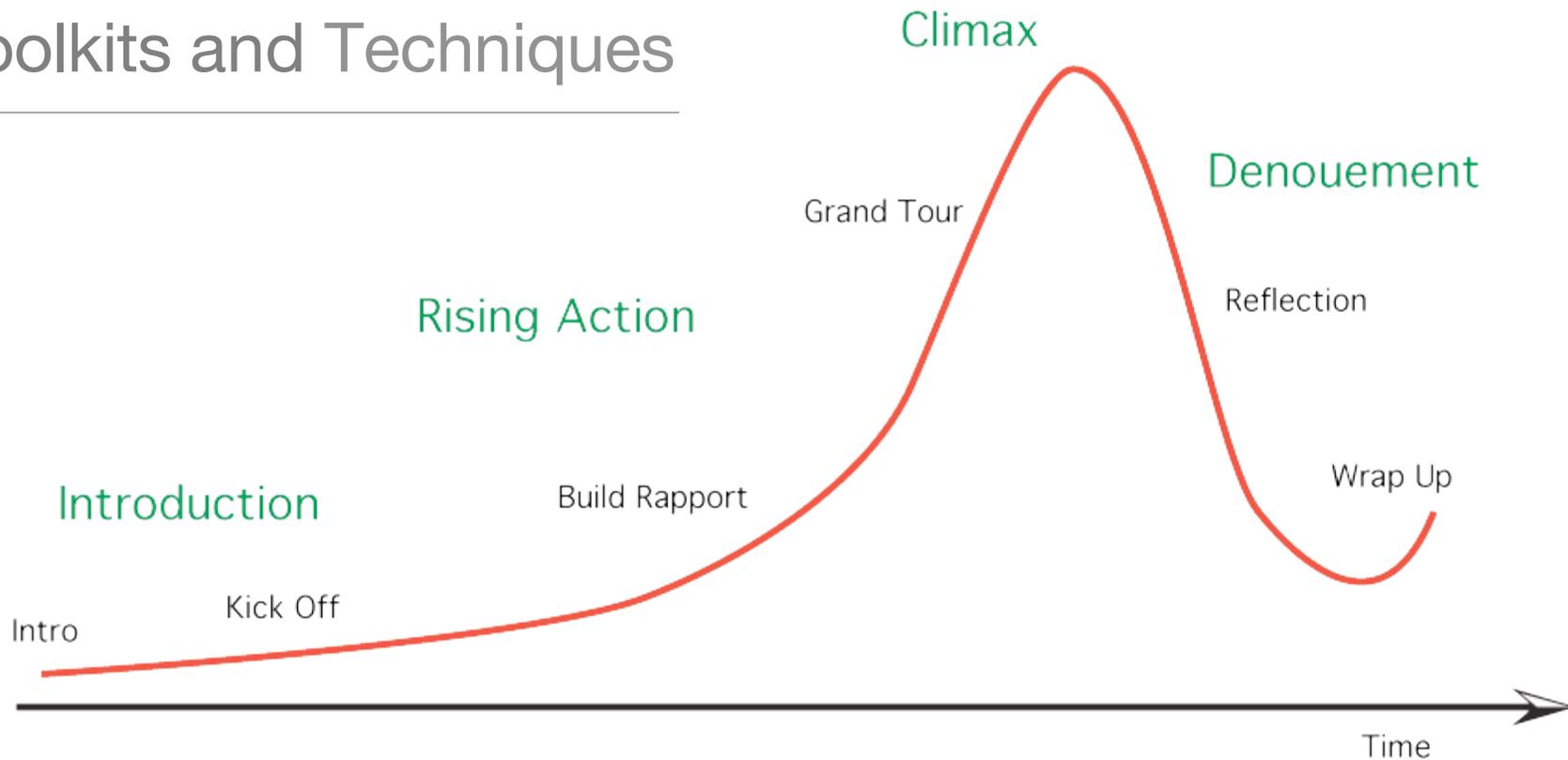
## Process

- Watch what people do
- Listen to what people say
- Listen to what people say about what they do
- Look more for what people are thinking and doing than the words they say



# Toolkits and Techniques

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## Interview Structure

### Introduction and Kick Off

- *Set up a comfortable place for the interview*
- *Describe your purpose*
- *Let them know their knowledge is important*

### Build Rapport:

- *Ease defensiveness through reassurance*
- *Start with general concrete questions, then explore their experiences*
- *Let them tell the stories they want to*

### Grand Tour

- *Ask interviewee for a narrated tour of the setting*
- *Ask questions, act out scenarios*

### Reflection

- *At end of interview explore more abstract feelings and thoughts*

### Wrap-Up

- *Expect important information after interview is "over"*

# Concepts

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## Narratives and Story Structure

- are the stories that sustain and transmit culture; cultural vessels
- pass through generation to generation; they are timeless
- are representative of our values and belief systems

## Stories are highly effective

- memorable, natural
- very informative: news (visual/verbal)
- spread quickly (word of mouth to the twitter feed)
- highlight social tensions or injustice

## Examples:

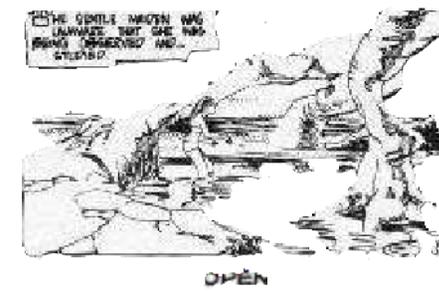
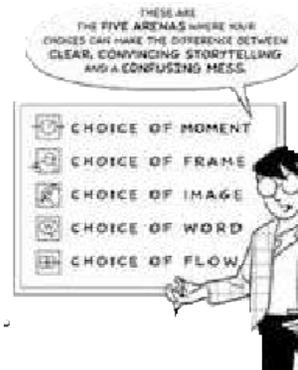
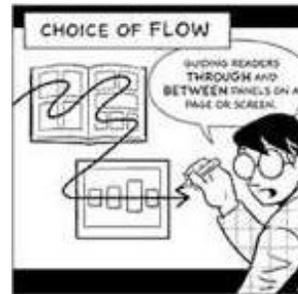
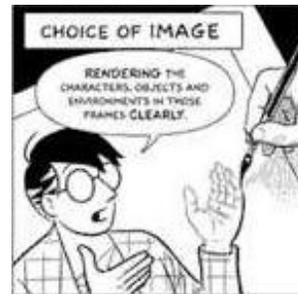
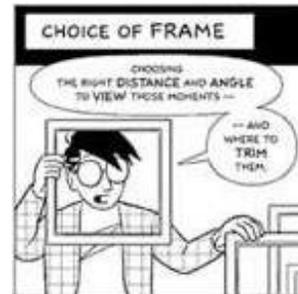
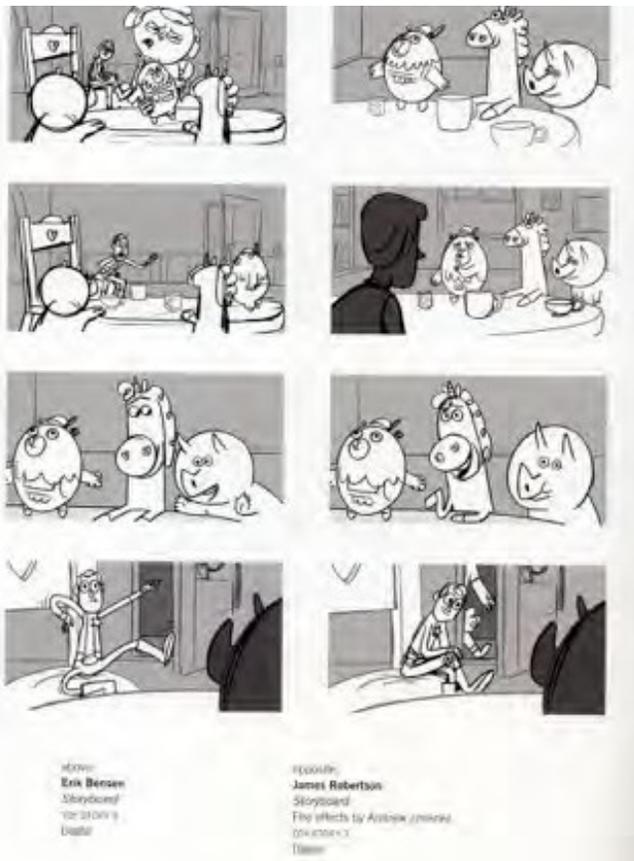
- Religious / Bible Stories: “Great Flood”
- Spoken / Oral tradition: “the Odyssey”
- Books / Novels: Bradbury / Orwell
- Plays / Movies: Batman Dark Knight: Crime drama, morality play



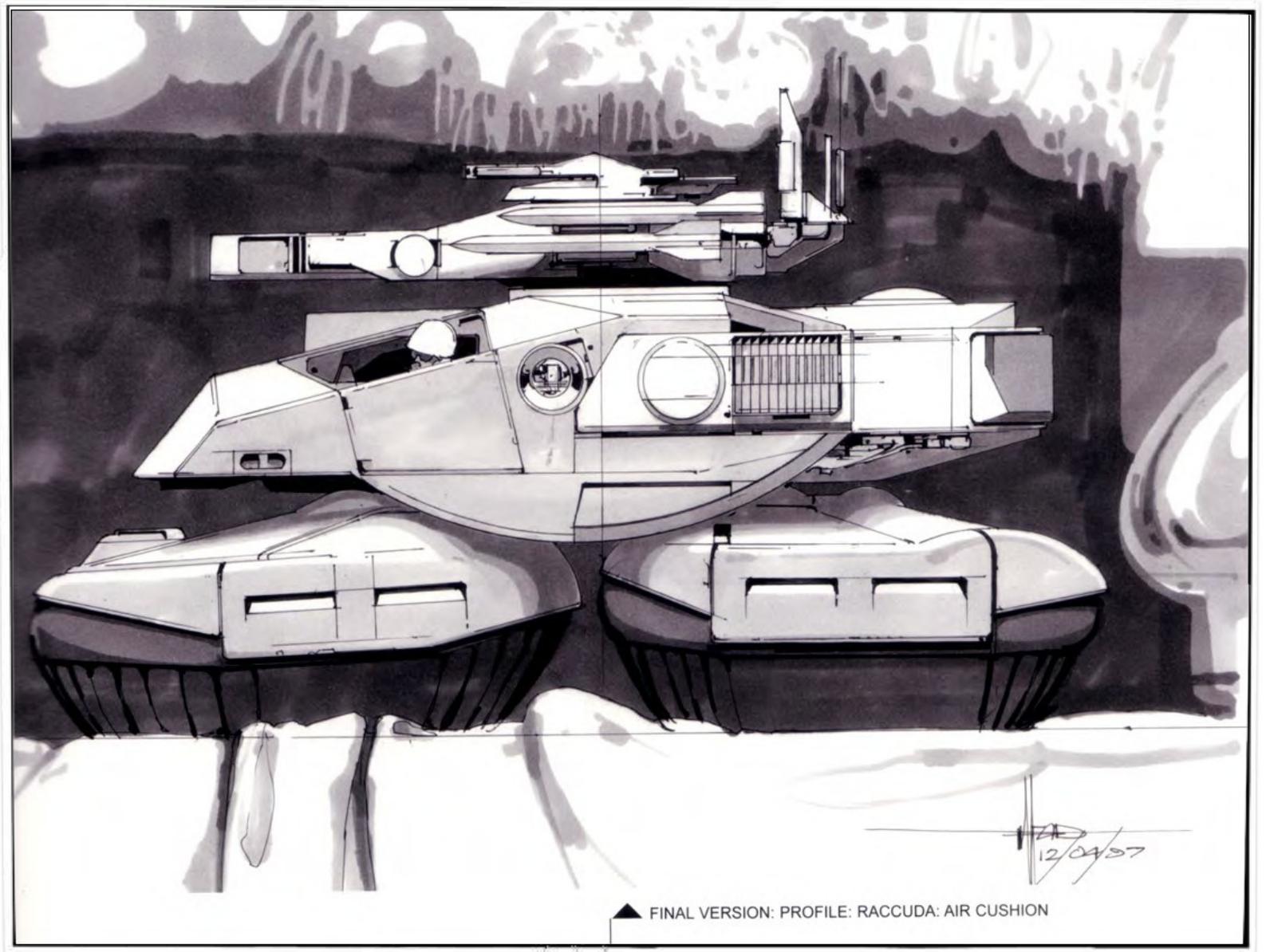
# Toolkits and Techniques

## Storyboarding

- Comic Book vernacular
- Basic, Visual Story Structure (1st draft)
- Moquette & Animatics



Q & A



# Think about Electives in the School of ID

ID 3320 Design Methods  
Wayne Li, [wayne.li@coa.gatech.edu](mailto:wayne.li@coa.gatech.edu)

ID 2401 Visual Design Thinking  
ID 4418 Design Sketching

ID 4106 Parametric Product Modeling  
Kevin Shankwiler,  
[kshankwiler@gatech.edu](mailto:kshankwiler@gatech.edu)

