3D FREEHAND SKETCHING FOR ENGINEERS

HKISC @ HK Polytechnic University
Kien Hoang 7th March 2013
sketch

noun. a rough drawing representing the chief features of an object or scene and often made as a preliminary study

verb. to make a sketch

ept. from Italian schizzo, literally, splash
Introduction
Introduction

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Introduction
Introduction

...to communicate ideas...
- quickly
- clearly
- effectively

...to stimulate further discussions...

...ultimately, to aid the design process...
Introduction

Sketching to generate ideas
Introduction

to develop ideas
Introduction

to understand ideas
Introduction to refine ideas
Introduction to refine ideas

- Stainless Steel Fin (~70%)
- Access Cover Plate
- View of Underside
- CHS Spine
- Site Connection using Concealed Bolted Fixing
- Access Panel (Removable Cover)
- CHS Bottom Flange (~870)
- Side View
- Double Clevis Plates allow CHS Bottom Flange to Pass Through
Introduction to refine ideas
Introduction

to deal with the 4th dimension
Introduction

to deal with the 4th dimension
Introduction

to deal with the 4th dimension
Introduction
to deal with the 4\textsuperscript{th} dimension
Introduction
to deal with the 4th dimension
Introduction to sell an idea

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to sell an idea
Introduction

or just for fun!

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Introduction

• develop the skills of freehand sketching, in 3D, for the purpose of representing engineering-type objects and structures.

• technical background assumed, but with little or no formal training in technical drawing.

• Using observational approach – quick ‘n dirty
2 parts concentrating on:

**Form:**
learning to appreciate geometrical basis of objects being drawn

**Emphasis:**
highlighting features of importance through composition
Each session will consist of:

10 min: introduction & underlying theory

35-50 min: class exercise

10 min: feedback
Everybody can draw. You just don’t all know it yet!
1 – Form

(the importance of thinking *inside* the box...)
5 minute sketch of your phone charger…
1. Form

All objects & structures can be broken down into basic constituent geometrical ‘units’. These are:

- Cube
- Cylinder
- Cone
- Pyramid
- Pyramid
- Sphere
1. Form

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1. Form

Learn to look at all objects in terms of their bounding boxes.
1. Form

TOP LIGHT

TOP surfaces in light
Under surfaces shaded.
Shadow cast on floor.

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1. Form

Sketching - process by which these 3D forms are transferred onto a 2D surface.

Similar to map projection - 3D curvature of globe becomes 2D flat piece of paper

Important to get spatial proportion & relationship right, within object and between objects.
1. Form

Importance of *proportions*

*proportions between different parts of an object*

*proportions within an object*
1. Form

The growth of the head is very gradual, only adding 3 inches up and down from the first year to adulthood. The legs grow nearly twice as fast as the torso.
1. Form
Try drawing the following
Importance of *spatial relationships*
3D Projection – representing 3D volume on 2D page
1. Form

3D Projection – representing 3D volume on 2D page

“military” projection

“Chinese” projection

“isometric” projection

All these are examples of “parallel” projections – lines do not converge to a point as in “linear perspective” projection
Chinese projection (also known as Cavaliera)
1. Form

Linear perspective

*The Annunciation*
Carlo Crivelli (1430-1494)

*The Battle of San Romano*
Paolo Uccello (1397-1475)
30° isometric projection gives fairly accurate representation without too much distortion. 30° angle is convenient for drawing, a very good starting point for 3D sketching…
30º isometric projection (cont...)
30° isometric projection – summary

• it’s a drawing convention – think top, front, and side views

• allows simple, unambiguous representation of objects

• you can scale from it

• very useful for engineering application where we usually have to visualise things that do not yet exist (as opposed to still-life drawing where we have to reproduce what is there)
30° isometric projection – putting into practice

- imagine drawing space as 3D cube with Cartesian coordinates
- X and Y axes form horizontal base plane. These axes are shown at 30° to horizontal line on page – not orthogonal
- Z axis is vertical. Always shown as vertical on drawing
- distances along all three axes are equal – i.e 1 unit on x axis is the same length on paper as 1 unit on y or z axis. But angles are not preserved

Tip: right angle triangle 2 units high by 3.5 units long will give 30°
1. Form

Step 1
- draw base grid at 30° to horizontal
- draw in verticals

*Remember distances along all 3 axes are equal. But axes are not orthogonal*
1. Form

**Step 2**
- sketch in bounding box(es), noting the relative proportion of the component members

*Remember the bounding boxes*
Step 3

- eye in position of major features - e.g. corner, notch, angle, etc
- draw in further bounding boxes as necessary for these features
1. Form

Step 4

- fill in details, again bearing in mind relative position and size

*Always work inwards - global to detail!*
Common errors
1. Form

Draw your phone charger
1. Form

Draw your phone charger
1. Form

Draw your phone charger

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exercise 4
1. Form

Draw your phone charger
Draw your phone charger
1. Form

Draw your phone charger
1. Form

Examples
Examples
Draw this connector detail in 3D
1. Form

Like so
1. Form

Examples

![Sketch of a 3D freehand sketched object]

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1. Form

Summary

bounding box - look for it

spatial relationship - find it

Isometric projection - X, Y @ 30°, Z vertical. Always.

distances along axes are equal

Work inwards - global to detail
1. Form

- PAZ0-75 Cladding Panel
- UC6 Corner Column
- Slot in METSEC to accommodate DTW
- Window Terminates Here
- Refer to BH/S/SK168.0 for member sizes schedule
- METSEC 172.015 Capping member all round
- W/Office Ribbon Window corner wrap-around detail:
  - Grid 4, 6: Level 1
  - Grid 14, 6: Level 1 & 2

BH/S/SK 172
KH/14.08.03
1. Form

Bearing Replacement Sequence:
1. Jack-up bearing to unload
2. Slide out existing bearing
3. Replace with new

Deck Supporting Stubs

Transverse Member to Side-Arm Node Arrangement

Transition from 3 faces of side arm to 4 faces of mast section

Structure created by welding skin onto a skeleton comprising full-section diaphragm with curved bar or chisels at corners

Reduced diaphragm spacing at areas of high curvature

Smooth transitions of surface created using smaller panels

Elliptical Section Transverse Member fabricated from bent plates

Boxed space on pier head for bearing replacement jack

Stainless steel pin with cover plate

Fabricated bilinear to main structural steel in place
1. Form
2 – Composition & Emphasis

(really stressing the point...)
2. Composition

The composition of a drawing or sketch can have an important impact on how effectively the information is communicated.

Applies not just to drawing but also to print media generally.

Very useful for things like report writing, presentation board and, indeed, illustration for oral presentations.
2. Composition

Simple rules of composition

1. forward planning is essential!
2. Composition

Board 1: Site Appraisal

- Site photo
- Site photo
- Site photo
- Water meadow
- Flow
- Desire line
- River Thames
- List of parameters & constraints
- Md's prelim site sketch
- Old map extract
- To village?
2. Composition

Board 2: Typology & Precedent (Appropriate to current context)

Bascule
- Typical
- Pros & Cons
- Photo & Diagram

Swing
- Pros & Cons
- Thorane Picture?

Retractable
- Bridge in Germany?
- Pros & Cons
- Retractable

Fixed: Cable Stay / Arch
- Diagram?
- Pros & Cons
- Photo(s)?
2. Composition

Simple rules of composition
2. make sure there’s enough room on the paper!
2. Composition

Simple rules of composition

3. Natural progression: Western reader will instinctively scan a page like so. Compose drawing to conform to this viewing pattern.
2. Composition

*Bacchus and Ariadne*

*Titian (1487-1576)*
2. Composition

Simple rules of composition

4. Linear progression: again, for Western readers, intuitive from left to right. Bear this in mind when doing sequence drawings, etc.
Simple rules of composition

5. Rule of thirds: psychologically, points occurring at lines dividing picture into thirds form natural focus points for human viewers.
2. Composition

Rain, Steam, and Speed – The Great Western Railway,
Joseph Mallord William Turner (1775-1851)
2. Composition

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2. Composition

PRINCIPLE OF OPERATION:
- BRIDGE IS SELF-COUNTERWEIGHTED
- CAN BE POWER-OR HAND-OPERATED
- ONE MOVEMENT SIMULTANEOUSLY DEPLOYS AND SLINGS BRIDGE INTO LOCATION
- KINETIC & STATIC EQUILIBRIUM TO BE QUESTED!
- DECKS DO NOT NEED TO TOUCH GRANITE

CENTRAL PILE PIER
BRIDGE IS BALANCED AT ALL TIMES SO
THE ONLY WORKS IN
COP & SHEAR
(REACTIONS OF OPERATING
tORQUE)

RACK WELDED TO SPINE. GLASS
SLIDER PLATE AIMS TO PREVENT TRAPPING
HAZARD

MAX LENGTH OF
EACH LEAF ~ 9 TO 10m

~ 1000
~ 200 DEEP RSJ
~ 1000

OPTION 1
SPINNER

CAN PROBABLY BE MADE REVERSIBLE!

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3. Composition

橋梁 1 - 无限之环 BRIDGE 01 - INFINITY LOOP

Image courtesy of 10 Design
2. Composition

Summary

- the presentation can often be just as important as the content being presented

- forward planning is essential, even for simplest of sketches, before pen goes to paper

- pay attention to composition of sketch and how it relates to the page – natural progression, rule of thirds etc…
effective hand sketching is not a black art – everybody can do it, with a little bit of practice

most important thing is to use your eyes. Take some time to see what you’re looking at - again, this takes practice

start putting into practice what you’ve learnt today. Practise!
What next?

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....thank you for attending