

A Study of Usability of Sketching Tools Aimed at Supporting Prescriptive Sketches

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CENTRO PARA LA INNOVACIÓN
DE LA EMPRESA INDUSTRIAL



UNIVERSIDAD
POLITECNICA
DE VALÈNCIA



Overview

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Prescriptive sketches are usually drawn,
after conceptual design is over,
to prepare the creation of digital 3D models.

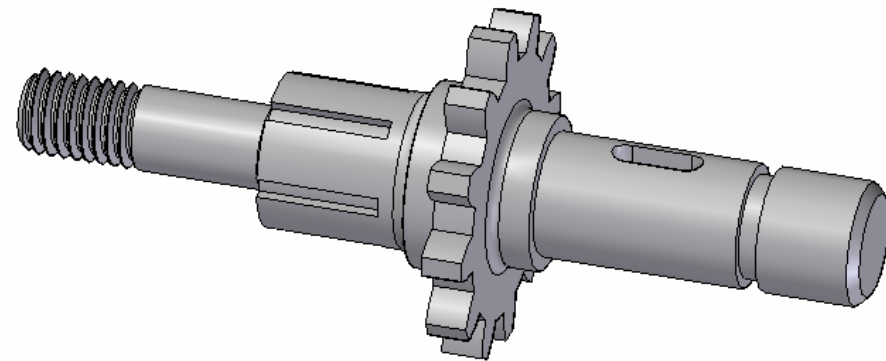
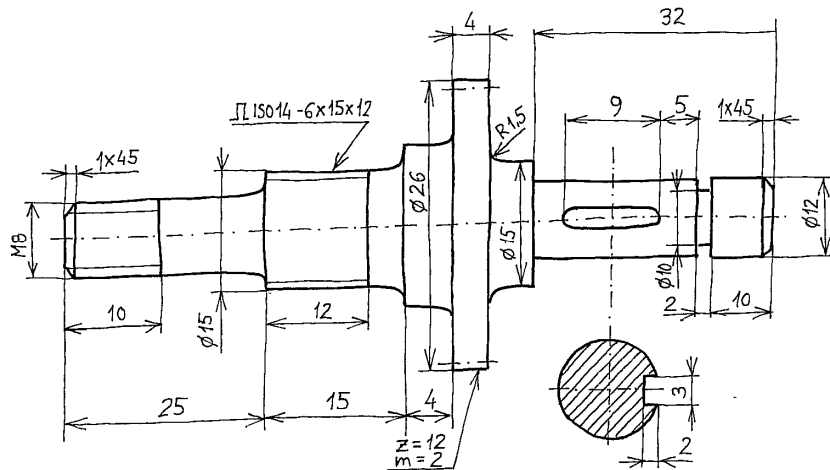
Overview

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Prescriptive sketches are usually drawn, *after* conceptual design is over, to prepare the creation of digital 3D models.

Designers and draftsmen use them as “screenplays” that guide the creation of the final 3D model.



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Prescriptive sketches are still paper-and-pencil.

in spite of the existence of some
academic or even commercial,
computer tools.



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Prescriptive sketches are still paper-and-pencil.

in spite of the existence of some academic or even commercial, computer tools.

In this paper, we defend the **hypothesis** that this is because current computer tools are less usable than paper-and-pencil sketches and do not possess significantly improved functionality.



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According to the classification by Ferguson [Fer92], we distinguish:

✓ *thinking sketches* used to focus and guide non-verbal thinking;

✓ *talking sketches* employed to support discussion on the design with colleagues;

✓ *prescriptive sketches* applied to give instructions to the draftsman who is in charge of making the final drawing.

or 3D Model!

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or 3D Model!

We focus on this



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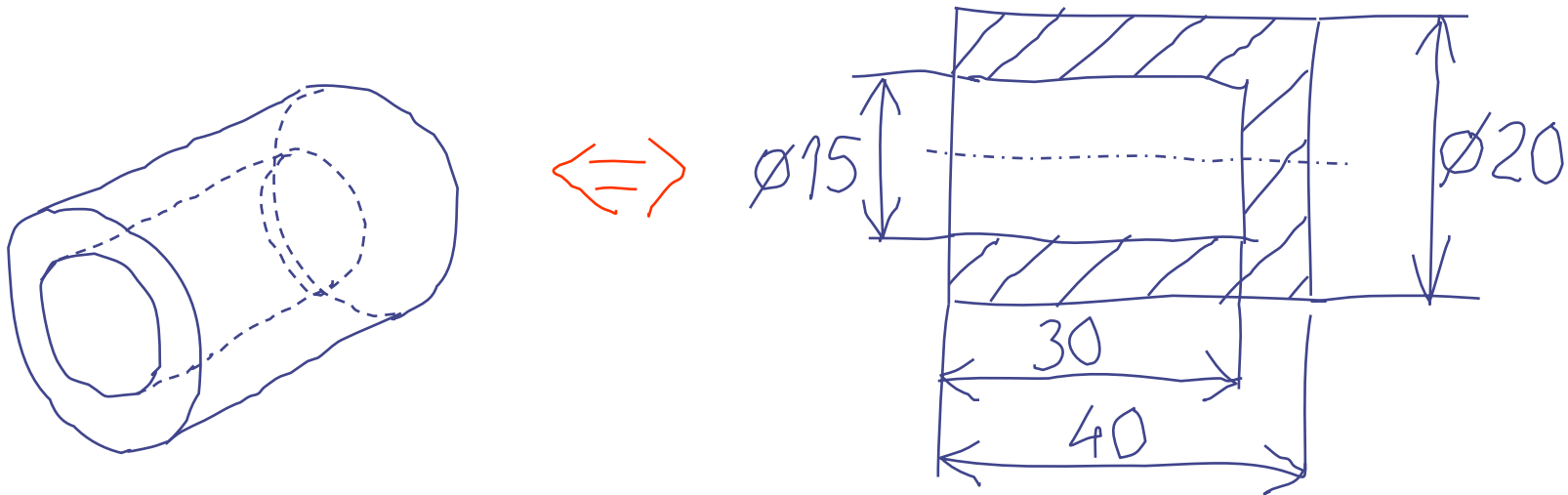
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Prescriptive sketches clearly differ from other sketches as they contain:

- ✓ Many standardized conventions (like dimensions)
- ✓ Cutted views with hatchings
- ✓ A large etcetera of icons and symbols

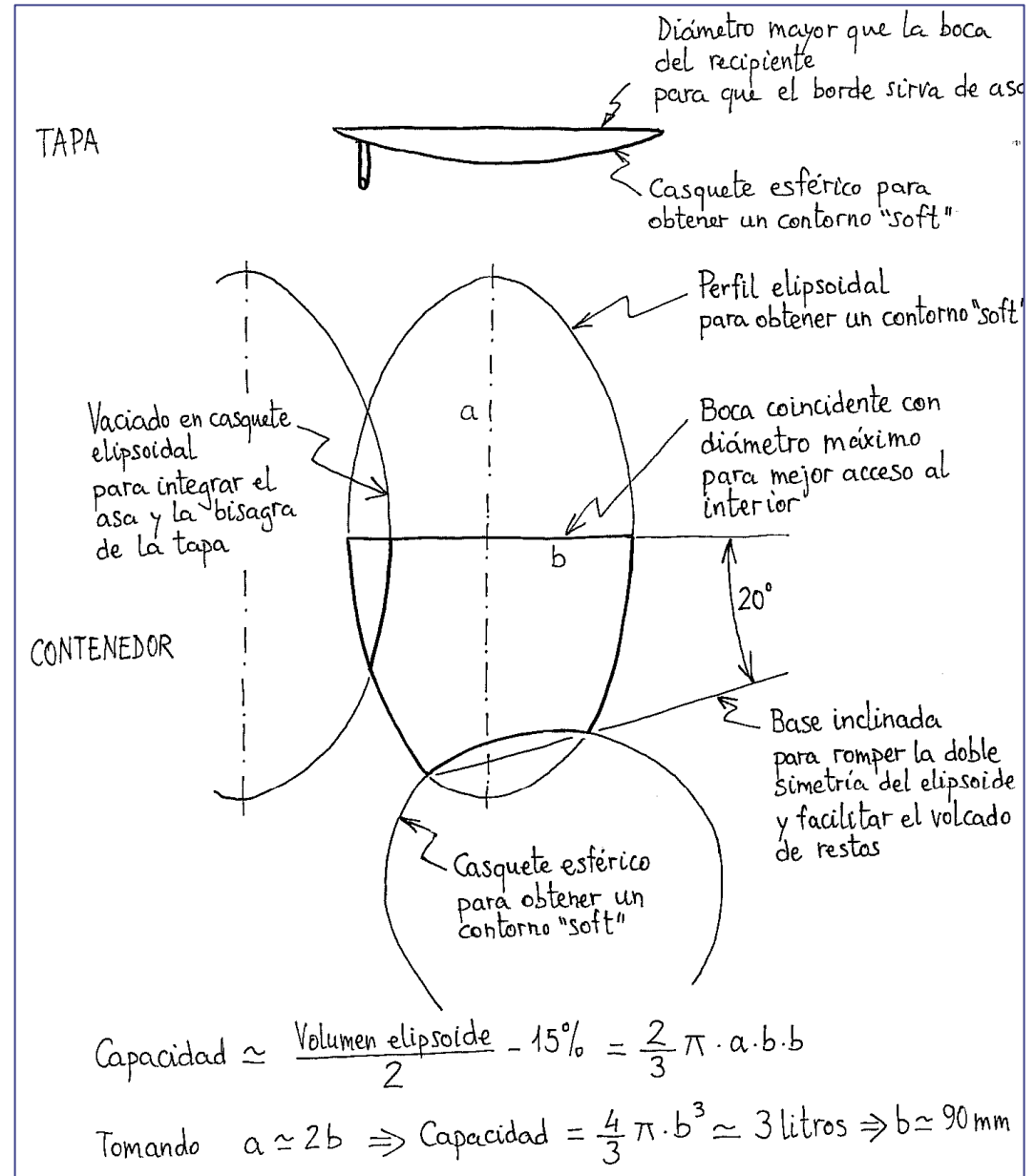


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Litter bin: conceptual design

Thinking sketches

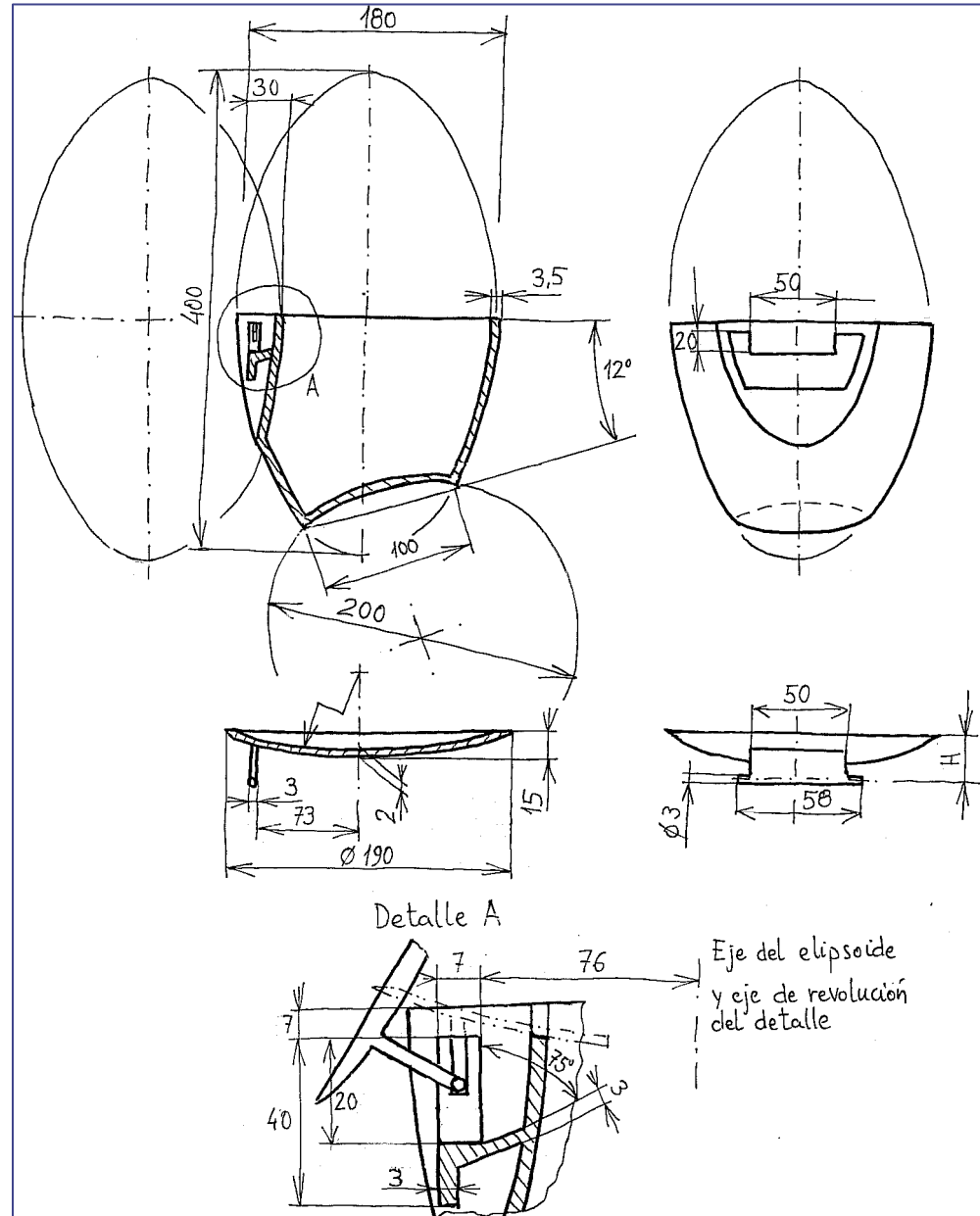


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Litter bin: detailed design

Prescriptive
Sketches
("screenplays")

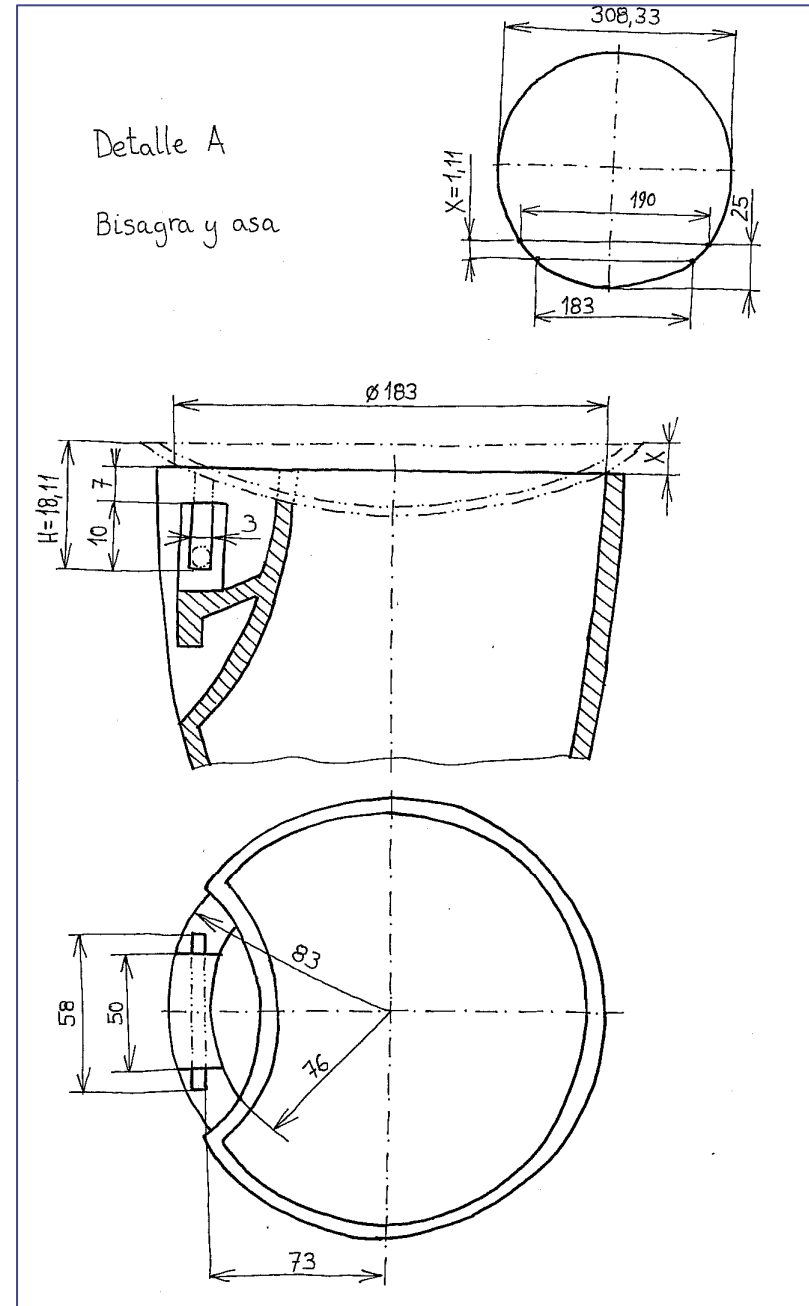


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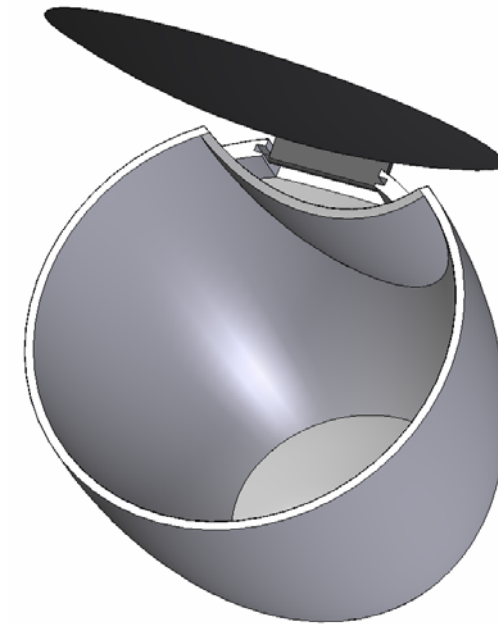
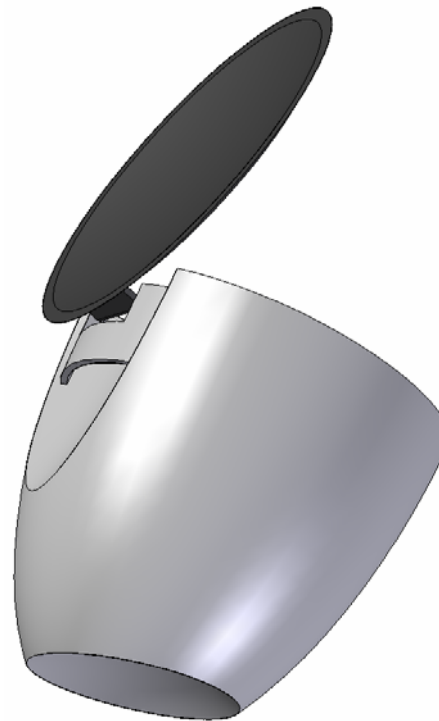
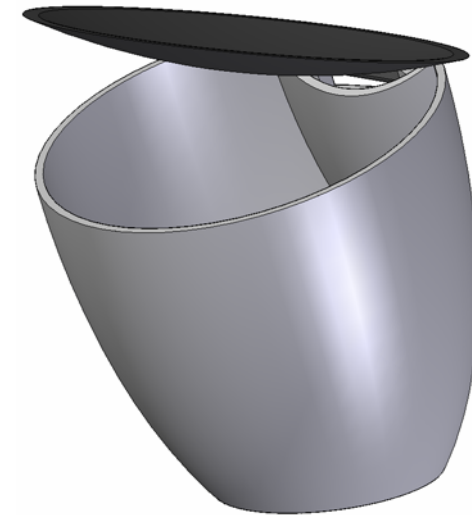


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Litter bin:
3D model

3D
obtained
from the
"screenplay"

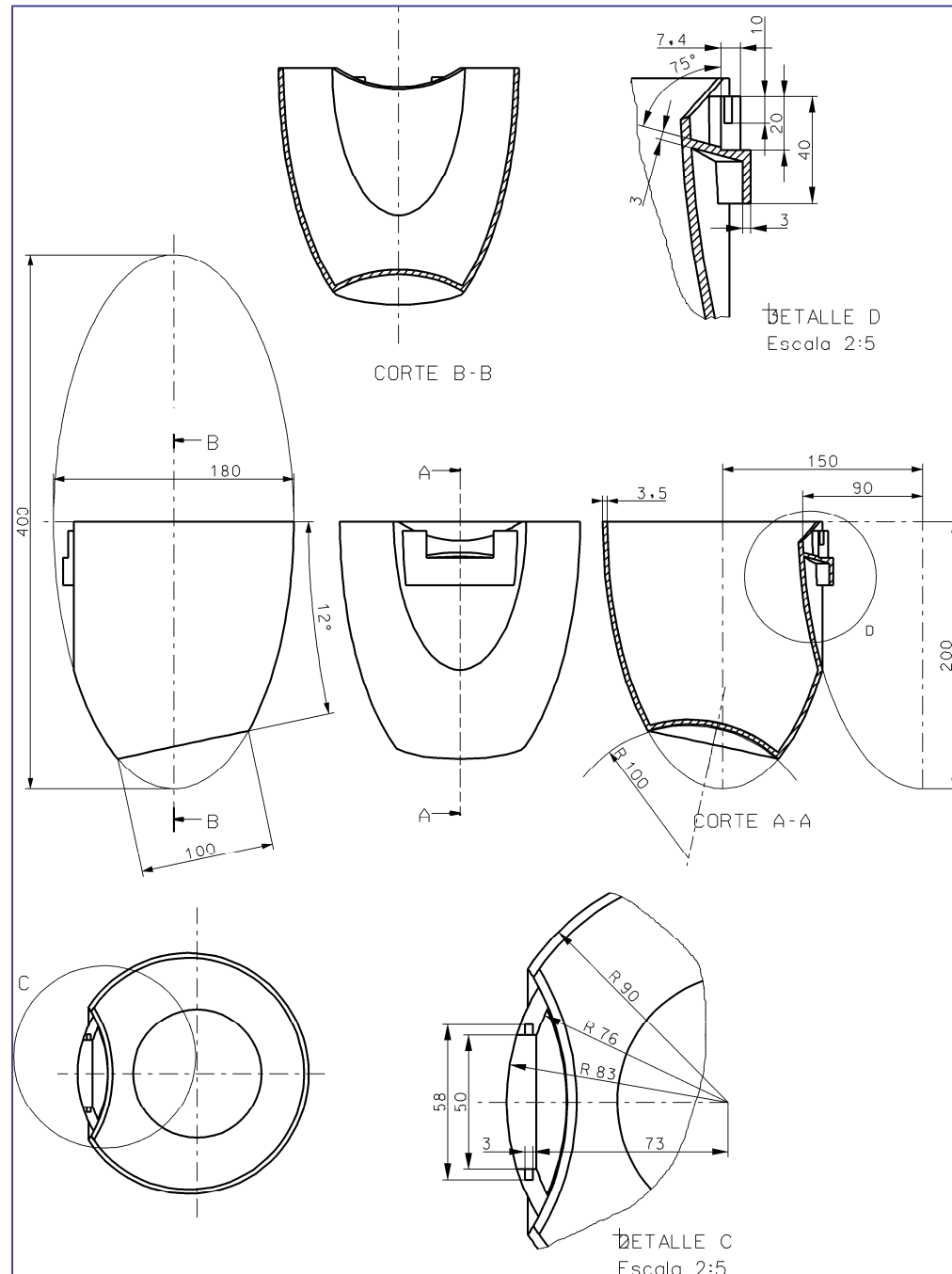


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Litter bin: manufacturing blueprints

"Tidied up"
Prescriptive
Sketches

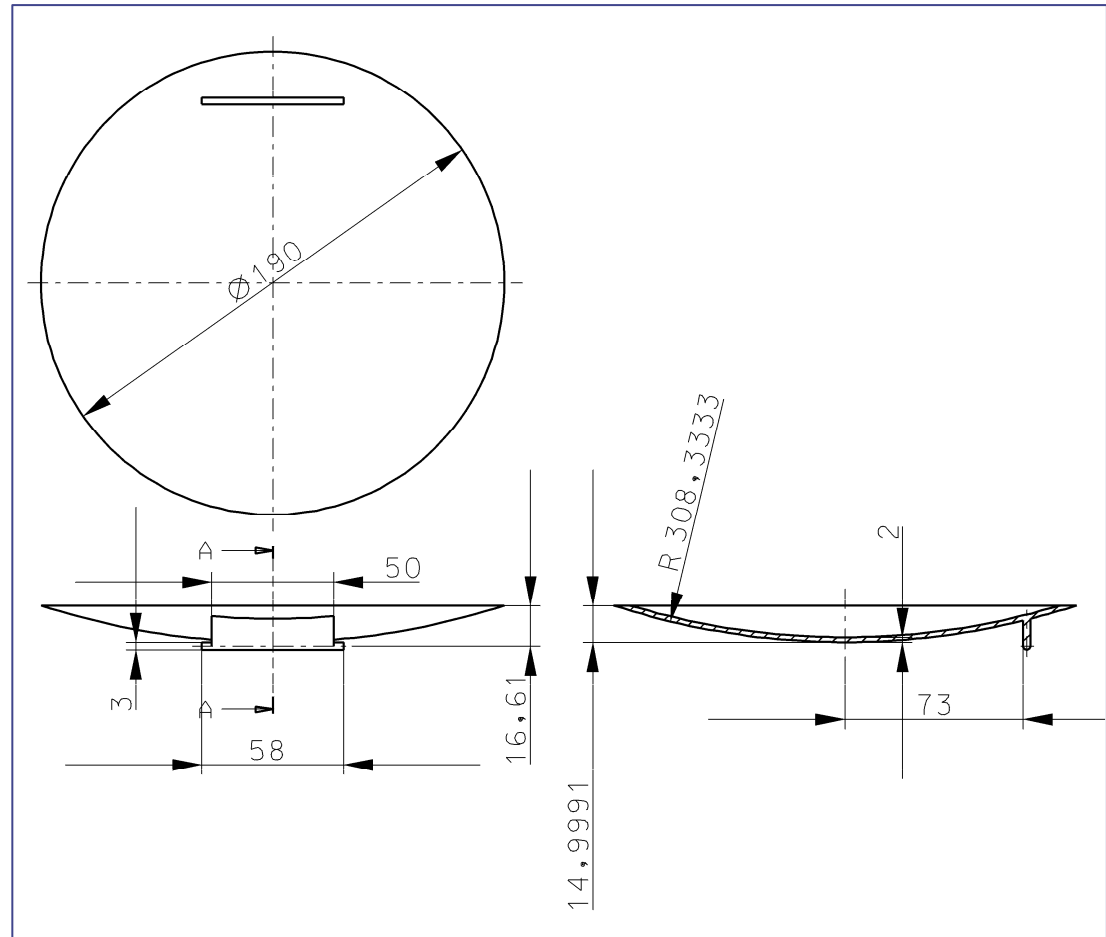


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"Tidied up"
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Litter bin:
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Apart from the advantages of
paperless office,
“plain” digital prescriptive sketches
do not solve any *real* problem.

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Apart from the advantages of paperless office,
"plain" digital prescriptive sketches
do not solve any *real* problem.

since paper-and-pencil sketching is

- simpler,
- polyvalent and
- well suited

for giving instructions to the draftsman in charge of making the final drawing or 3D model

and general and automatic generation of 3D models is not feasible!



Discussion

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It can be concluded that
**achieving or even enhancing the
usability of paper-and-pencil
is a key issue**
for the success of digital prescriptive
sketching.

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Following this assumption,
we did not investigate
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obtained in a simple virtual
paper and pencil scenario.

i.e., **sketch space should be
deliberately minimalist** [PA02].

However, adding some
extra functionality,
without suffering any
reduction in usability,
should increase the
acceptance of those tools!

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Our hypothesis is that
the less intrusive the CAS tool,
the better for the designer.

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Our hypothesis is that
the less intrusive the CAS tool,
the better for the designer.

We understand
“intrusive” as
equivalent to
attracting the
attention of the
designer.

In other words,
an intrusive interface
is permanently requiring the user
to do things,

and tends to gain
more and more control
on the process of fixing geometry
of a new shape or design

Questionnaire

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We decided to simulate a non-intrusive CAS tool by asking the interviewed people to draw a sketch on a tablet PC with the least intrusive digital drawing tool we could find.

It was compared against the typical 2D CAD sketching capabilities

Questionnaire

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We decided to simulate a non-intrusive CAS tool by asking the interviewed people to draw a sketch on a tablet PC with the least intrusive digital drawing tool we could find.

We opted by Microsoft's PAINT, but reducing its set of tools to just paintbrush and rubber.

It was compared against the typical 2D CAD sketching capabilities

UGS's SolidEdge, was chosen because of its availability and the familiarity that many of the interviewed had with it.

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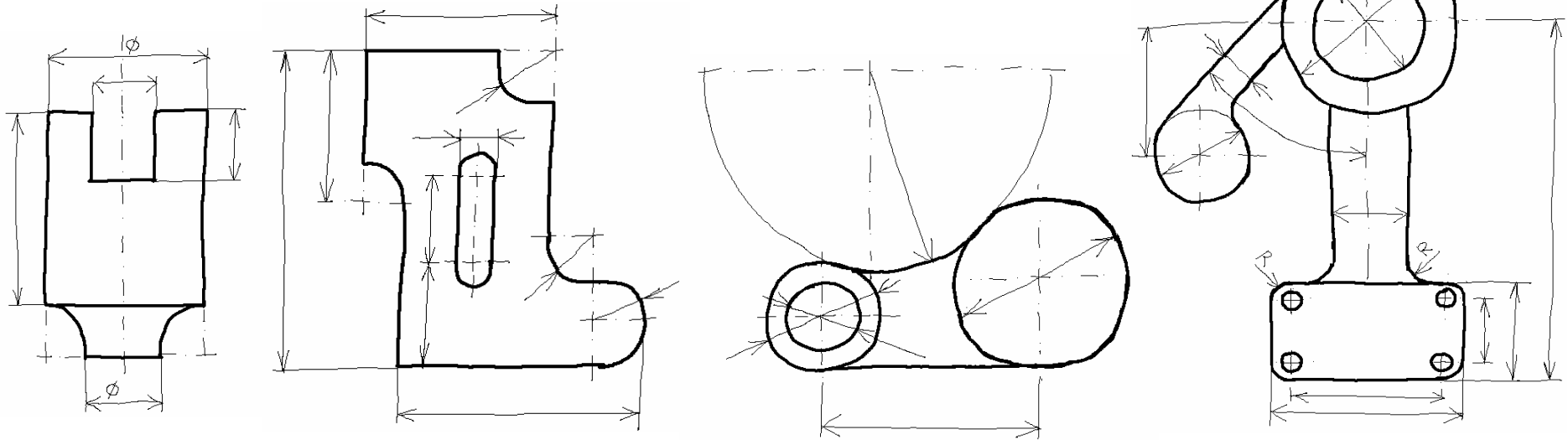
The respondents were asked to compare prescriptive sketching done in three different **scenarios**:

- 1 Hand (H)
- 2 Paint+tablet (P/t)
- 3 SolidEdge (S/E)

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We selected four **sketches**, intended to be representative of the most current sketch types, while being simple enough to allow completing the test in one hour



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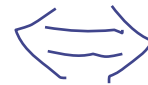
Our **population** was conceived as a mixture of experts (E's) and beginners (B's):

E's 8 teachers of engineering design and CAD,

B's 22 first year engineering students;
who gave us the point of view of beginners

Our aim in choosing those populations was to try to separate the "familiarity" issue from the underlying "usability" issue.

Some of our experts are mostly used to paper and pencil and dislike current software, while other are real experts in CAD teaching.



Our students have been taught in a computer-dominant environment, and feel less comfortable with paper and pencil.



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Finally, the respondents had to answer two groups of **questions**.

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1 Arrange the four sketches, scoring them from easiest (1) to most difficult (4).

2 Arrange, from most important (1) to less important (4), the following criteria to determine which is the most difficult sketch:

- a) the one that contains more lines
- b) the one that contains more curves
- c) the one that is less symmetrical
- d) the one that contains more angles

3 Signal the tool (H if hand, P if Paint/tablet or S if SolidEdge) with which you have obtained the best version of every sketch.

4 Arrange the tools (Hand, Paint/mouse, Paint/tablet and SolidEdge) scoring them from the easiest (1) to the most difficult (4).

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Enumerate the main advantages of hand-made drawings.

6

Enumerate the main advantages of Paint with tablet.

7

Enumerate the main differences between Paint with tablet and Paint with mouse.

8

Enumerate the main advantages of SolidEdge.

9

Add any observation you consider to be relevant.

Results

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First, it was checked that the order in which the respondents made the drawings did not significantly affect the results

Because the “pseudo-random” sequence that we introduced seemed to be enough to prevent a dominant order

Respondent	Sequence												
	Hand (H)				Paint/tablet (P/t)				SolidEdge (S/E)				P/m
	A	B	C	D	A	B	C	D	A	B	C	D	A
B01	1	2	3	4	7	8	9	10	5	6	11	12	13
B02	3	5	7	9	10	11	12	13	2	4	6	8	1
B03	5	6	7	8	1	2	3	4	9	10	11	12	13
B04	1	11	12	13	2	3	4	5	7	8	9	10	6
B05	5	6	7	8	1	2	3	4	10	11	12	13	9
B06	5	7	8	9	13	12	10	11	1	2	3	4	6
B07	10	11	12	13	6	7	8	9	1	2	3	4	5
B08	1	2	3	4	8	9	10	11	5	6	7	13	12
B09	2	3	4	5	6	7	8	9	10	11	12	13	1
B10	10	11	12	13	1	2	3	4	5	6	7	8	9
B11	10	11	12	13	1	2	3	4	5	6	7	8	9
B12	9	10	11	12	1	2	3	4	5	6	7	8	13
B13	1	2	3	4	9	10	11	12	5	6	7	8	13
B14	10	11	12	13	5	6	7	8	2	3	4	9	1
B15	1	2	3	4	10	11	12	13	6	7	8	9	5
B16	1	2	3	4	10	11	12	13	6	7	8	9	5
B17	9	10	11	12	1	2	3	4	5	6	7	8	13
B18	10	13	12	11	6	9	7	8	2	3	4	5	1
B19	1	2	3	4	5	6	7	8	9	10	11	12	13
B20	1	2	3	4	10	11	12	13	5	6	7	8	9
B21	6	7	8	9	10	11	12	13	2	3	4	5	1
B22	1	2	3	4	5	6	7	8	9	10	11	12	13
E01	9	10	11	12	5	6	7	8	1	2	3	4	13
E02	4	7	10	13	2	6	9	12	1	5	8	11	3
E03	1	2	4	5	3	7	8	9	10	11	12	13	6
E04	6	7	8	9	1	2	3	4	10	11	12	13	5
E05	1	2	3	4	5	6	7	8	9	10	11	12	13
E06	1	2	3	4	9	10	11	12	5	6	7	8	13
E07	1	2	3	4	5	6	7	8	9	10	11	12	13
E08	3	4	6	7	10	11	12	13	1	2	5	8	9
E09	1	2	3	4	5	6	7	8	10	11	12	13	9
Average	4,2	5,7	6,8	7,8	5,6	6,8	7,6	8,7	5,5	6,7	8,0	9,4	8,2
	1	4	7	9	3	6	8	12	2	5	10	13	11

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Finally, we did organize the “non-formal” answers to the non-formal questions:

Query	Answers
Advantages of HAND	<ul style="list-style-type: none"> a Fast and easy b Consents improvisations and imperfections c Low cost d Ergonomic e You can move the paper f It does not do what you want not. g Fully accessible everywhere
Advantages of TABLET	<ul style="list-style-type: none"> a Similar to hand b Clean and precise erasing c Fast d The output is already digitized in the computer e A little bit uncomfortable f Easy to understand g Does not consume real paper or pencil h Limitless drawing space and includes zooming facilities i Worse than hand for fast sketches, and worse than CAD for finished drawings
Differences tablet/Mouse	<ul style="list-style-type: none"> a It's more complex to draw with a mouse than with pen. b Pen is more precise than mouse. c Pen is more synchronized with cursor than mouse. d Straight lines are easier with mouse than with pen e Curved lines are easier with pen than with mouse
Advantages of CAD	<ul style="list-style-type: none"> a Lines are perfect b Easy to add geometrical constraints c Easy to dimension d Easy to transform sketches into 3D models e The drawing can be edited a posteriori. f Allows dimensioning / Requires dimensioning g Requires training
Free oppinions	<ul style="list-style-type: none"> a Tablet is a little bit uncomfortable b Tablet requires more training c Tablet is embarrassing for left-handed.

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We obtained some conclusions from the general results:

1 Our attempt to obtain four examples representative of four different levels of difficulty was validated by the arrangement of the respondents

example A was considered the least difficult (average 1.6), example B was the next (2.9), example C was the third (3.1) and example D was rated to be the most difficult (3.9).

2 We gained an interesting insight in determining what makes sketches more difficult: more curves (1.4); less symmetry (3.1), more angles (3.3) and more lines (3.6).

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3 Paper-and-pencil is still considered easier and “handier” than our simulation of a minimalist digital prescriptive sketching tool.

Achieved through Microsoft’s Paint limited to just using paintbrush and rubber

4 Hand drawings achieved similar scores (2.8) to Paint/tablet (2.9), although the execution time was a little bit greater (almost 20%, i.e. from 5.7 to 6.8 minutes)

Respondents achieved similar results, needing more time, but in an environment completely new to most of them!

Besides, the time was similar to the time required to complete SolidEdge drawings (where most of them had had extensive training)



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In spite of the above conclusions from the general results...

... we obtained much more interesting **opinions** from the non-formal questions.

They are much more interesting because they can guide the contents of the full study that should follow the pilot study!

They are much more interesting because they help us to discover unsuspected aspects of the question!

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1 Some respondents considered that the small *uncoupling* between tablet PC's pen and cursor distracts the draftsmen and reduces the accuracy of sketches.

physical separation between pen and cursor

A future task is exploring whether the uncoupling could be skipped by using other devices.

However, the unfamiliarity of the users with Tablet PCs may have left them disliking them. According to this, the hypothesis to be validated or rejected by future studies should be that in the long run there is little *fundamental* difference between the interface provided by a tablet PC and a piece of paper

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2 The second question addressed was measuring the validity of the belief that current “pseudo-sketchers” embedded into CAD applications can substitute hand made prescriptive sketches *without loss of usability*, at the time they increase functionality by semi-automatically aiding the user in creating the final model from the different views of the sketch

Respondents seem to put in value the increase of functionality given by SolidEdge, but still notice the loss in usability!

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*Thank you
for your
attention*

