So how might we find a process that enables us to design computer-based products with the same attention to user experience that we saw in the design of the OrangeX? I think that the answer lies in the OrangeX example, itself. Hence its importance.

It illustrated that the activity of sketching could be extended to other forms than just pencil on paper. The key here is to understand that sketching as I mean it has more to do with exercising the imagination and understanding (mental and experiential) than about the materials used. Hence, one might use pencil on paper, but one might also use a jar lid, a stick, and a piece of plasticine. It may even involve a computer. With the OrangeX example, the underlying process and objectives were the same, but the sketches themselves took on a more physical form than we have seen thus far. As I shall say more than once, the importance of sketching is in the activity, not the resulting artifact (the sketch). If sketches can take on physical form, be they 3D or sculptural, perhaps they can take on even more extended forms that will help us in our quest.

But how do we go deeper than this? If there are new forms of sketching, how can we pursue them?

One thing that we know is that sketches for experience and interaction design will likely differ from conventional sketching since they have to deal with time, phrasing, and feel—all attributes of the overall user experience. How rich is that?

Experience is a very dynamic, complex and subjective phenomenon. It depends upon the perception of multiple sensory qualities of a design, interpreted through filters relating to contextual factors. For example, what is the experience of a run down a mountain on a snowboard? It depends upon the weight and material qualities of the board, the bindings and your boots, the snow conditions, the weather, the terrain, the temperature of air in your hair, your skill level, your current state of mind, the mood and expression of your companions. The experience of even simple artifacts does not exist in a vacuum but, rather, in dynamic relationship with other people, places and objects. Additionally, the quality of people’s experience changes over time as it is influenced by variations in these contextual factors. (Buchenau & Suri 2000; p 424)

In light of this, let us ask again:

What is the nature of sketching in interaction design?
How do you sketch interaction?
What is to an interactive system what the early sketch in Figure 35 is to Lance Armstrong's time trial bike?
What are the fundamental skills required for sketching interactive systems?
What is the underlying process that one should follow to do this effectively and consistently?
What should be included in Sketching 101 in an Interaction Design curriculum?
The tack that we are going to pursue is that sketching in interaction design can be thought of as analogous to traditional sketching. Since they need to be able to capture the essence of design concepts around transitions, dynamics, feel, phrasing, and all the other unique attributes of interactive systems, sketches of interaction must necessarily be distinct from the types of sketches that we have looked at thus far. Nevertheless, to be considered sketches, they must be consistent with the attributes that we discussed earlier, namely:

- Quick
- Timely
- Inexpensive
- Disposable
- Plentiful
- Clear vocabulary
- Distinct gesture
- Minimal detail
- Appropriate degree of refinement
- Suggest and explore rather than confirm
- Ambiguity

From our analysis of sketching in traditional design, we are able to find a compass that can help guide us in our exploration of sketching in this new domain. Although the surface of the renderings will be different, the underlying properties should be the same. Therefore, not only do we have a compass, we have a litmus test that helps us categorize examples that we encounter.
Figure 51: The Dynamics of the Design Funnel

The design funnel begins with ideation, and ends with usability testing. The former is largely dominated by sketching, which enables ideas to be explored quickly and cheaply. More refined (and expensive) prototypes provide the basis for the testing at the later stages of design. Where testing is a key concern, the most dominant artifacts are more refined (and expensive) prototypes. The transition from one to the other is represented by the transition from orange to yellow in the figure. As we progress, our overall investment in the process grows. This is indicated by the rising arrow and the y-axis label on the left. The y-axis label on the right side of the figure emphasizes that as our investment increases, so should the weight of the criteria that we use to evaluate our design decisions. In other words, you don’t manage ideation the same way, or with the same rigor, as usability. Finally, the circular arrows are a reminder that we include users throughout the iterative process, not just during usability testing.


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Now that what I mean by sketching interaction is becoming a bit more clear, it is inevitable that someone is going to ask something like, “Isn’t what you are calling a sketch just another word for prototype or low-fidelity prototype?” The answer is emphatically, “No!” The distinction between a sketch and a prototype is—for me at least—one of the most interesting things to emerge as I went down this path.

Sketches and prototypes are both instantiations of the design concept. However they serve different purposes, and therefore are concentrated at different stages of the design process. Sketches dominate the early ideation stages, whereas prototypes are more concentrated at the later stages where things are converging within the design funnel. Much of this has to do with the related attributes of cost, timeliness, quantity, and disposability. Essentially, the investment in a prototype is larger than that in a sketch, hence there are fewer of them, they are less disposable, and they take longer to build. At the front end of the funnel, when there are lots of different concepts to explore and things are still quite uncertain, sketching dominates the process.

These notions are captured graphically in Figure 51. The circular arrows reinforce that the whole design phase is an iterative, user-centred process. The coloured change reflects a transition from a concentration on sketching at the front to one concentrating on prototyping at the back. Related to this, and signified in the colour coding, is the accompanying transition from ideation to usability testing.

From the management perspective, perhaps the most important component of Figure 51 is the ascending red arrow. What this says is that the weight of the criteria by which ideas or concepts are injected or rejected varies with the investment made in them. Stated simply, at the beginning, ideas are cheap, so “easy come, easy go” and “the more the merrier.” As we proceed, we have more and more invested in the concepts in play, hence we need to adopt increasingly formal or explicit criteria for evaluating what goes, what stays, and where we invest our resources.

Because the investment in the product is low, the front end is the one time in the product pipeline when one can actually afford to play, explore, learn, and really try and gain a deep understanding of the undertaking. In fact, too much concern for quality too early may well have a negative effect. I found a wonderful example illustrating what I mean by this referred to in a blog from someone called Bill Brandon:
Figure 52: The Sketch to Prototype Continuum

The difference between the two is as much a contrast of purpose, or intent, as it is a contrast in form. The arrows emphasize that this is a continuum, not an either/or proposition.
The ceramics teacher announced on opening day that he was dividing the class into two groups. All those on the left side of the studio, he said, would be graded solely on the quantity of work they produced, all those on the right solely on its quality. His procedure was simple: on the final day of class he would bring in his bathroom scales and weigh the work of the “quantity” group: fifty pounds of pots rated an “A”, forty pounds a “B”, and so on. Those being graded on “quality,” however, needed to produce only one pot—albeit a perfect one—to get an “A.” Well, came grading time and a curious fact emerged: the works of highest quality were all produced by the group being graded for quantity. It seems that while the “quantity” group was busily churning out piles of work—and learning from their mistakes—the “quality” group had sat theorizing about perfection, and in the end had little more to show for their efforts than grandiose theories and a pile of dead clay. (Bayles & Orland 2001; p. 29)

Baxter (1995) argues that because the investment is so low and the opportunity to explore options is so high at the start, that this is also the stage in the product development lifecycle when you have the potential to realize the highest return on investment. Of course, this is a double-edged sword. It is also the point in the process where the consequences of an undetected bad decision, or an opportunity missed, can cost you the most (in real dollars or missed revenue). So, as the saying goes:

Fail early and fail often.

And learn. But adequate investment at this stage happens too infrequently, especially with software companies. The paradox is that those same firms that can’t afford a relatively small planned investment in design at the front end, seem quite able to afford the far higher unexpected and unbudgeted (but predictable) high back-end costs that result from a bad product being late and underdelivering on its potential.

Jumping in and immediately starting to build the product, even if it does get completed and ship, is almost guaranteed to produce a mediocre product in which there is little innovation or market differentiation. When you have only one kick at the can, the behaviour of the entire team and process is as predictable as it will be pedestrian:

You cling ever more tightly to what you already know you can do—away from risk and exploration, and possibly further from the work of your heart. (Bayles & Orland 2001; p.30)

Robert Cooper (1993; 2001) compares managing product development costs in terms of the type of risk analysis that one would use at the poker table, or in managing an investment portfolio. Mike Baxter summarizes this in terms of the following Gambling Rule:

When uncertainties are high, keep the stakes low. As the uncertainties reduce, increase the stakes. (Baxter 1995; p.10)

In summary, what all this says is that we must manage the front-end of the process differently than the back-end, regardless of whether we are looking at things in the large (the overall product pipeline—design, engineering, sales, etc.) or in the small (within the design funnel itself, where we must manage the sketching and ideation phase differently than we manage the back-end prototyping stage).
At this point we risk being so bogged down in discussions about processes, roles, responsibilities, diagrams, and so forth, that we lose sight of why we are doing this in the first place: to design products that people want, need, like, and can use. Yet, it was only around the discussion of the Design Funnel shown in Figure 51 that I really said anything about user-centred or usage-centred design, usability testing, or any of the other associated buzz words. At least for anyone who knows me, this may seem especially curious. Therefore, let me inject a few comments.

First, this is largely explained by the fact that I simply take it for granted that the user is both considered and involved throughout the process. Arguing for the need for user involvement in a modern book on product design is as pointless as a discussion about the need to know the rules of arithmetic in an advanced mathematics textbook.

Second, there are various traditions, such as user-centred design and participatory design, that have a well-established literature on their approach to user involvement in the design process. Rather than put forward an alternative to these traditions, I would like to view what I write in this volume as complementary to, and compatible with, these traditions. Instead of trying to write a comprehensive handbook on design, my hope is to contribute something that augments the approaches already in place.

Third, it is precisely a concern for users that underlies the value of the approach to design that I discuss in this volume. Techniques fundamental to the design phase, such as sketching and prototyping, mean that iterative user involvement, participation, testing, and validation can occur much earlier than is often the case. Furthermore, this can happen in a form that captures the interactive nature of the system. The consequence is that user input can begin early enough to influence the design of the product. (Participatory design is one obvious approach to this, but not the only one. But it certainly lends support to what I am saying.) User involvement then obviously continues through the engineering phase, in the form of usability testing.
Design Process

Elaboration
(opportunity-seeking:
from singular
to multiples)

Reduction
(decision-making:
from broad
to specific)

starting point

Design Process

focal point

Design Process

Elaboration
(opportunity-seeking:
from singular
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Reduction
(decision-making:
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starting point

Design Process

focal point

Figure 53: Overlapping Funnels

The reduction that results from decision making is balanced by the constant generation of new ideas and creativity that open up new opportunities to improve the design.

Source: Laseau 1980; p. 91


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The attentive reader will notice something about how I have represented the design process in Figure 51. It is a funnel that is narrower at the end than at the beginning. What that implies is that no matter how many great ideas get tossed into the hopper, in one sense, there is less at the end than at the beginning.

Of course, from another perspective, that is not true. At the beginning all we have are perhaps some ideas, some hope, and some ambition. At the end, ideally, we have something concrete—a design for a well-formed product.

Laseau (1980) has a nice way to capture this. He has an alternative representation of the process that is made up of two superimposed and opposing funnels, as shown in Figure 53. This representation prompts me to do something that earlier I said I would not do, namely give you one of my definitions of design. So here goes:

Design is choice, and there are two places where there is room for creativity:
1. the creativity that you bring to enumerating meaningfully distinct options from which to choose
2. the creativity that you bring to defining the criteria, or heuristics, according to which you make your choices.

This formulation of the process makes explicit the fundamental importance of both the generative and reductive aspects of the design process. It also has a fairly close correspondence to a quote from the French poet Paul Valéry:

Invention depends on two processes. The first generates a collection of alternatives, the other chooses, recognizing what is desirable and appears important among that produced by the first. What one calls “genius” is much less the contribution of the first, the one that collects the alternatives, than the facility of the second in recognizing the value in what has been presented, and seizing upon it. (Translation: Bill Buxton)

Each of the two processes or agents corresponds to one of Laseau’s funnels. The expanding funnel represents the generation of the possible opportunities, or options...
Figure 54: Flexible Approach to Concept Generation and Selection

This is yet another variation on representing the design funnel. After the front-end design work and the Product Design Specification (PDS), we see the process alternating between concept generation (CG) and concept convergence (CC), with the overall process gradually converging to the final concept.

Source: Pugh 1990; p. 75
from which one can select. The converging one represents the making of choices from among those options, and the gradual convergence onto the final design.

I like this figure for what it adds. And yet, it has its own weaknesses. Although it graphically highlights that the generation of new ideas is ongoing throughout the process, it doesn't reflect how the range of things that we can consider narrows as we converge on the final design.

The other thing that it doesn't show, but that is important to keep in mind, is that for the process to work, we must generate and discard much more than we keep. This is what Pugh (1990) has called controlled convergence. This leads us to yet another representation, that seen in Figure 54. The key take-away from this figure is how it illustrates the design funnel as alternating between adding and eliminating concepts—Concept generation (CG) which expands the scope of the funnel, and concept convergence (CC), which narrows the funnel.

Let me quote what Pugh says about this, since I don’t think that I can improve upon his words:

… it allows alternate convergent (analytic) and divergent (synthetic) thinking to occur, since as the reasoning proceeds and a reduction in the number of concepts comes about for rational reasons, new concepts are generated. It is alternatively a generative (creative) and a selection process. An essential feature of this approach is the comparison of each alternative concept, in turn, with a peer concept in such a manner to render a fixed viewpoint on any one concept impossible. (Pugh 1990; p 74)

This is all very much in keeping with the notion of design as choice that I articulated earlier. It also reinforces the concept of design rationale (MacLean, Young & Moran 1989); that is, constantly being able to articulate the reason for your decisions. And, the notion of the peer concept reinforces the notion that design is not a straight path. We always need things to which we can compare any option. That is, the question is not, “Do I want this?”, but rather, “Do I want this rather than that, and why?”

Ultimately, the common thread in any of these funnel-shaped representations, regardless of their variations, is that they converge. That is, not all ideas survive. More get tossed out (hopefully for good reason) than kept.

And guess what? Some of the ideas that get thrown out will be yours. Furthermore, these may include some that you believe to be among your best. To succeed, you not only have to learn to live with this, you have to learn to live for it. Here is how I see it:

**People on a design team must be as happy to be wrong as right. If their ideas hold up under strong (but fair) criticism, then great, they can proceed with confidence. If their ideas are rejected with good rationale, then they have learned something. A healthy team is made up of people who have the attitude that it is better to learn something new than to be right.**

It has to be this way. Hence, one of the mantras of a healthy group is:
Figure 55: Another View of the Funnel
This variation on Pugh’s illustration emphasizes the iterative nature of the process.
Source: Pugh 1990; p. 75
There are no dumb questions. There are no ideas too crazy to consider. Get it on the table, even if you are playing around. It may lead to something.

This freedom to consider anything needs to be balanced by an understanding that choices have to be made, and that not everything considered will find its way into the final design. But remember, what does find its way into the design may well have gotten there precisely because of some other idea that did not. As with a novel, the whole plot may turn on a character (in this case, an idea) that got killed off before the *grande finale*.

There is one other point that I want to make regarding otherwise great ideas not making it into the final product. To do so, I need to give you another one of my definitions of design:

**Design is compromise.**

I know that this flies in the face of the image of the designer genius, whose ideas should not be tampered with. But as we have already discussed, the design team represents a number of stakeholders, such as design, engineering, product management, marketing, and so on. Each has its own legitimate priorities, and these priorities will often come in conflict with each other. An example might be making the appropriate trade-off between the “right” interface from the designer, and the “possible in my lifetime” reality confronting the engineer.

Scott Jenson (2002) calls this Yin/Yang Design, and makes two crucial points. First, the sooner that these issues are recognized and addressed, the less impact there will be on the final product. Second, the only way for this to happen is if all the stakeholders are part of the design team from the start. It is their engagement in the type of interactions that we are describing here that can lead to the most effective balance between the various yin/yang forces.

For example, as Figure 52 indicated, sketches serve to suggest, propose, and question. Part and parcel of this is to provoke scrutiny and criticism of the ideas that they represent. They need to be challenged and tested from all angles. However, if this is not managed well, egos can get bruised, tempers can flare, and serious damage can be done.

What keeps things healthy and stimulating, as opposed to the source of resentments and bruised egos, is the process by which these choices are made. Central to this is the need to be as clear about the rationale for various decisions as we are about the decisions themselves.

Being explicit about the **design rationale** accomplishes at least two things. It helps guide the process away from decision by bullying, browbeating, or seniority to one where the reason for the decision is understood, and can be articulated by anyone on the team.

Understanding the rationale for a decision is also a wonderful remedy to being a prisoner of your own decisions. That is, after a decision is made, you might learn something new. If you know why you made a previous decision, then it becomes much easier
Figure 56: And yet Another View of the Funnel

This variation on Pugh’s illustration emphasizes the fact that the process is the same as one converges to ever finer levels of granularity of design issue.

Source: Pugh 1990; p. 75
(and safer) to determine if it should be changed. As well, when the project goes to
engineering, it is often of great help if those doing the implementation understand the
why, as well as the what, of a design decision.

Successful execution of a design depends on communication, and capturing the
design rationale is an important component in this.

Your partners on the design team must be your strongest critics. One of the most
important reasons for having a team with diverse skills and experience—from design
through technology, business, manufacturing, and marketing, for example—is the
richness and breadth of perspective that they bring to evaluating the ideas on the table.
Here is my spin on this:

From “the glass is half full” perspective, the thing to remember here is that one of
the most positive forms of criticism is a better idea, and frequently, that better idea
would never have come about were it not for the idea that it replaces.

Scott Jenson talks about “criticizing your way to a solution.” I like this way of putting it.

Anyone who has taken a drawing class knows that the group critique at the end of
each session is as important, if not more, than the time spent drawing. Learning how
to give and take criticism is as much a part of the pedagogical intent as is the develop-
ment of drawing technique.

This practice is fundamental in art and design education; however, one cannot as-
sume that it is part of the normal training of other disciplines, such as computer sci-
ence, that make up the interaction design team. This is why I am making such a big deal
about it here, and will come back to it later.

This difference in background is one of the things that needs to be taken into ac-
count in how the design group is managed. As will be discussed in the next section,
one way to facilitate this is through the design of the design environment itself—the
physical and social ecology within which the team works. With care, this is one of the
most powerful tools that can be deployed to encourage and facilitate collective discus-
sion, debate, criticism and the exploration of ideas.
Figure 57: Design Echoed in Elementary School
Source: Queensferry Primary School
I have to say it: sketches are social things. They are lonely outside the company of other sketches and related reference material. They are lonely if they are discarded as soon as they are done. And they definitely are happiest when everyone in the studio working on the project has spent time with them.

Sure, the act of creating a sketch can help an individual designer work through concepts and refine ideas. And sometimes, that is all that is required. The sketch can be discarded as soon as it is finished. But more often than not, a significant—if not the greater—part of the value comes in encouraging its social life. And for such encounters, the sketch’s favourite meeting place is the wall-mounted corkboard.

I will go further: a design studio without ample space to pin up sketches, reference photos, clippings, and the like, such as those illustrated in the photo spread of Figure 58, is as likely to be successful as an empty dance club.

Common inquiry must be rooted in a history of shared experience at many levels ... (Ivan Illich 1971)

This aspect of the physical and social ecology of the design studio serves a range of important functions. You don’t make a decision on whom to marry based on first impressions. So why would you want to do so when selecting the design concept that you want to pursue, and therefore live with? Yet that is too often what happens in design reviews, where management is seeing the concept for the first time. (I’m not saying that first impressions are not important, or not sometimes right. I’m just saying that you can’t rely on them alone.)

Humans create their cognitive powers by creating the environments in which they exercise those powers. At present, so few of us have taken the time to study these environments seriously as organizers of cognitive activity that we have little sense of their role in the construction of thought. (Hutchins 1995; p. 169)
Now I suspect that my kindergarten teacher would take exception with this, given that she clearly spent a significant amount of her time organizing the environment precisely for the purpose of stimulating learning. Likewise, as the illustrations accompanying this chapter clearly show, designers are extremely conscientious about doing the same thing.

It is common for designers to pin up part-finished drafts around the area in which they are working so that they are open to their own reflections (even at times when attention is not specifically directed to them) and to responses from colleagues. (Black 1990; p. 286)

These examples don’t negate Hutchins’ comment. Rather, they illustrate what is at risk if we do not pay adequate attention to the design of the environments in which we work.

Hanging work in the environment lets it “bake in.” It is there in the background, and becomes part of the ecology of the studio. You live with it for a while, and with familiarity grows either insight or perhaps contempt. Displaying the work in juxtaposition with other material helps in the discovery and exploration of new relationships. Not only that, it provides the opportunity for your fellow designers to get to know, and comment on, this “partner” with whom you all might be spending a considerable amount of time.

However, the corkboard is no more what it appears to be on the surface than is a sketch. Its importance lies less in the object itself, than in the social and cognitive behaviours to which—through its affordances—it provides the catalyst (Gaver 1991). It isn’t just something into which you can easily stick map pins. It is an awareness server: a technology that affords a sense of shared awareness of common references among the design team. Thereby, it provides an important and efficient means for communication and collaboration. It is as important to the design process as sketching itself.

That is not quite right, since that statement still treats sketching and corkboards as separate entities, as objects in the material sense. They are not. The notion of sketching should be, and henceforth will be, considered to embrace the larger notion of the term. It encompasses the social and physical ecological aspects that we have discussed, such as shared awareness, baking in, collaboration, communication, juxtaposition, and critique. And it does so within and through explicitly designed spaces and locations in the design studio.

All of this is the norm, and hardly even needs to be said in a traditional design studio. But what we are talking about in this book is not the traditional design studio, but a studio populated
by people who come from other traditions than, for example, graphic or industrial design. This needs to be taken into account, as is highlighted by the following comments that Scott Jenson made to me on reading an early draft of this chapter:

You make a really good point here but there is a deep social phenomenon to take into account. I did create a pin up board space in a central location…. It was dismal failure. People never felt their sketches were 'good enough' to put up on the board. There was something daunting about the physical act of leaving their cubical space and going into the global shared space to post something. Some went up of course but I received feedback that it seemed like a 'bold move' to do it. It's like the refrigerator door in the family kitchen. It's only cool for Mom to put things up. Now this could be British versus American values but I was a bit stumped by this reluctance.

However, I did notice that people were more willing to put sketches up within their own cubicle. This made me try to reconfigure the cubes so that we had four cubes around a communal space with low 4-foot corkboards in the center (to keep the informal social interaction in place). It also was not a 'wall' but a small posting area so it didn’t cut into the space as much. I was only able to get this to work for a single group (crazy British office politics) and I can't really claim too much here but this group certainly used this space actively. I should note they also just talked more in general as they were easier to engage on many levels.

In another group, they couldn’t get a corkboard but they had a communal white board and it was used in much the same way. There were impromptu meetings held around the board and once two people started talking, it was a very obvious, impromptu gathering and inevitably pulled in one or two more. Those moments made my heart glad, I just wish I could have figured out ways to do it more.

The reason that I shared these comments is that they are so effective in making the point that—in contrast to some of the articles that I have read in the popular press recently—simply plunking a bunch of corkboards or foamboards around your work space does not magically turn it into a design studio. These are artifacts with certain affordances, but their effective use requires as much attention to the cultivation of the culture of the studio as to the detailing of the architectural space.