

CS445 / SE463 / ECE 451 / CS645
Software requirements specification
& analysis

My Self-Administered Hair Cut
During the Covid-19 Lockdown

Summer 2020

Daniel Berry

Goal

By the second month of the 2020 Covid-19 lockdown, I, like a lot of other people, needed a hair cut.

My normal haircut is a simple all around cut done with a clipper with a 1 inch riser, making every hair 1 inch long and not attempting to hide my growing baldness by letting some hairs be longer than 1 inch so that they will cover bald areas 😊.

I do have the barber trim the edge of the hair to clean lines, causing the hairs near the edge to be shorter than 1 inch.

An Engineering Problem!

So I got to thinking, maybe I could give myself a haircut using a purchased clipper with a 1 inch riser.

I decided to approach the cutting of own hair as an engineering problem!

Really!!! 😊

Haircut Requirements

First, I determined a statement of requirements, R , that is applicable to me in normal times, e.g., prior to the Covid-19 lockdown.

R : (A): Every hair on my head, except near the edge of the hair, is cut to exactly 1 inch (25 mm) long

and

(B): Every hair hanging over the edge of the hair is clipped to form a clean edge line.

Haircut Specification

First, I determined a statement of specification, S , that is applicable to me in normal times, e.g., prior to the Covid-19 lockdown.

S : (X): The barber cuts every hair on my head, using a clipper with a 1 inch (25 mm) riser

and then

(Y): The barber clips every hair hanging over the edge of the hair to form a clean edge line, using a clipper without any riser.

Attempted Entailment

Does $S \vdash R$?

Yes!

It seems that no D other than

- that dealing with the continued functioning of the clipper
 - that every hair on my head is at least 1 inch long
 - tacit assumptions about all haircuts
- are needed.

During Lockdown

During the lock down, I could not go to a barber, and I was living with no one else who might play the role of barber, in my bubble.

So I need to achieve the same R with a new S' in which the one who is doing the cutting and clipping is I!

$S':(X')$: I cut every hair on my head, ...

and (maybe not in the same order as before)

(Y') : I clip every hair hanging over the edge of the hair to form a clean edge line, ...

Hidden D Conjunct

Hm... so there *is* a domain assumption, a tacit one, that I overlooked:

D : Whoever operates a clipper can see what he or she is doing so as

- to cut everything that should be cut and
- to not cut anything that should not be cut

I cannot see what I am doing behind my head.

So D does not hold when I operate the clipper.

A New S' to Achieve R

So, is there a way to achieve R with an S' that works even if the clipper operator cannot see what he or she is doing?

I have seen some sorry results of self haircuts. There were places he or she cut too short, including bald spots, and there were places he or she cut too long. I wanted to avoid this “new look”, no matter how *in and cool* it is these days.

Recall and Precision

recall = percentage of right stuff that is found

precision = percentage of found stuff that is right

- A clipping has 100% precision if no hair on the head is cut shorter than 1 inch.
- A clipping has 100% recall if no hair on the head is left longer than 1 inch.

Guaranteed 100% Precision

The presence of a 1 inch riser on the clipper guarantees 100% precision. With the 1-inch riser, there is no way to cut any hair shorter than 1 inch long.

But any hair originally longer than 1 inch long, that misses meeting the clipper, because the clipper operator cannot see what he or she is doing and misses some spots with the clipper, or because the hair is bent...

will be left longer than 1 inch long.

So 100% recall cannot be guaranteed in any clipping.

Iterative Approach?

However, maybe an iterative approach might work:

loop

Attempt to cut every hair with multiple sweeps over the hair-covered part of my head using a clipper with a 1 inch riser

until

what falls to the floor indicates that no new hair got clipped in the just finished attempt

pool

Recall Approaches 100%

With each iteration, the recall should get closer to 100%, and we can decide to *accept that* after the third consecutive time that no new hair gets clipped in a sufficiently covering iteration, the recall *is* 100%.

The improvement to the recall of any iteration can be increased by fluffing up my hair with a comb at the beginning of the iteration, to reduce the number of hairs that are not sticking up straight up and are missed by the clipper.

Iterative $S' = X'$ and then Y'

This iterative procedure would lead to the following fragment of the specification:

(X'):loop

After fluffing up my hair with a comb, attempt to cut every hair with multiple sweeps over the hair-covered part of my head using a clipper with a 1 inch riser

until

for a third consecutive time, what falls to the floor indicates that no new hair gets clipped in the just finished attempt

pool

Abandoning Part of R

This X' takes care of the requirement A .

But what about requirement B , about trimming the edges of the hair?

I don't see any way to guarantee that I will cut every hair that should be cut.

More than that, I don't see any way to guarantee that I won't cut off too much.

So I will abandon B as not achievable if I am cutting my own hair.

Weakening R

So I will abandon B as not achievable if I am cutting my own hair.

This abandonment is an example of weakening R to R' in order to make the S' strong enough to entail R' !

Final $S' \vdash R'$

R' : Every hair on my head is cut to exactly 1 inch long

S' : **loop**

After fluffing up my hair with a comb, attempt to cut every hair with multiple sweeps over the hair-covered part of my head using a clipper with a 1 inch riser

until

for a third consecutive time, what falls to the floor indicates that no new hair gets clipped in the just finished attempt

pool

Key Lemma of Validation of $S \vdash R$

The recall and precision analysis proves that the assumption

D: Whoever operates a clipper can see what he or she is doing so as

- to cut everything that should be cut and
- to not cut anything that should not be cut

does not need to hold because

- the iteration guarantees that everything that should be cut is cut and
- the 1 inch riser guarantees that nothing is cut that should not be cut.

Validated $S \vdash R$

So $S \vdash R$!!!

Observe how a thorough analysis of the $D, S \vdash R$ before implementation started assured me that the implementation would proceed as expected.

But more was needed!

Guess what!!!!

Showing Other Geeks

I showed my analysis to all my kids, geeks all, and to some geeky friends in an attempt to find flaws in my reasoning.

None could find any, but each warned me of a lousy outcome nevertheless 😊, like good engineers who understand Murphy's Law.

These showings to other geeks were none other than *inspections* of my requirements analysis!

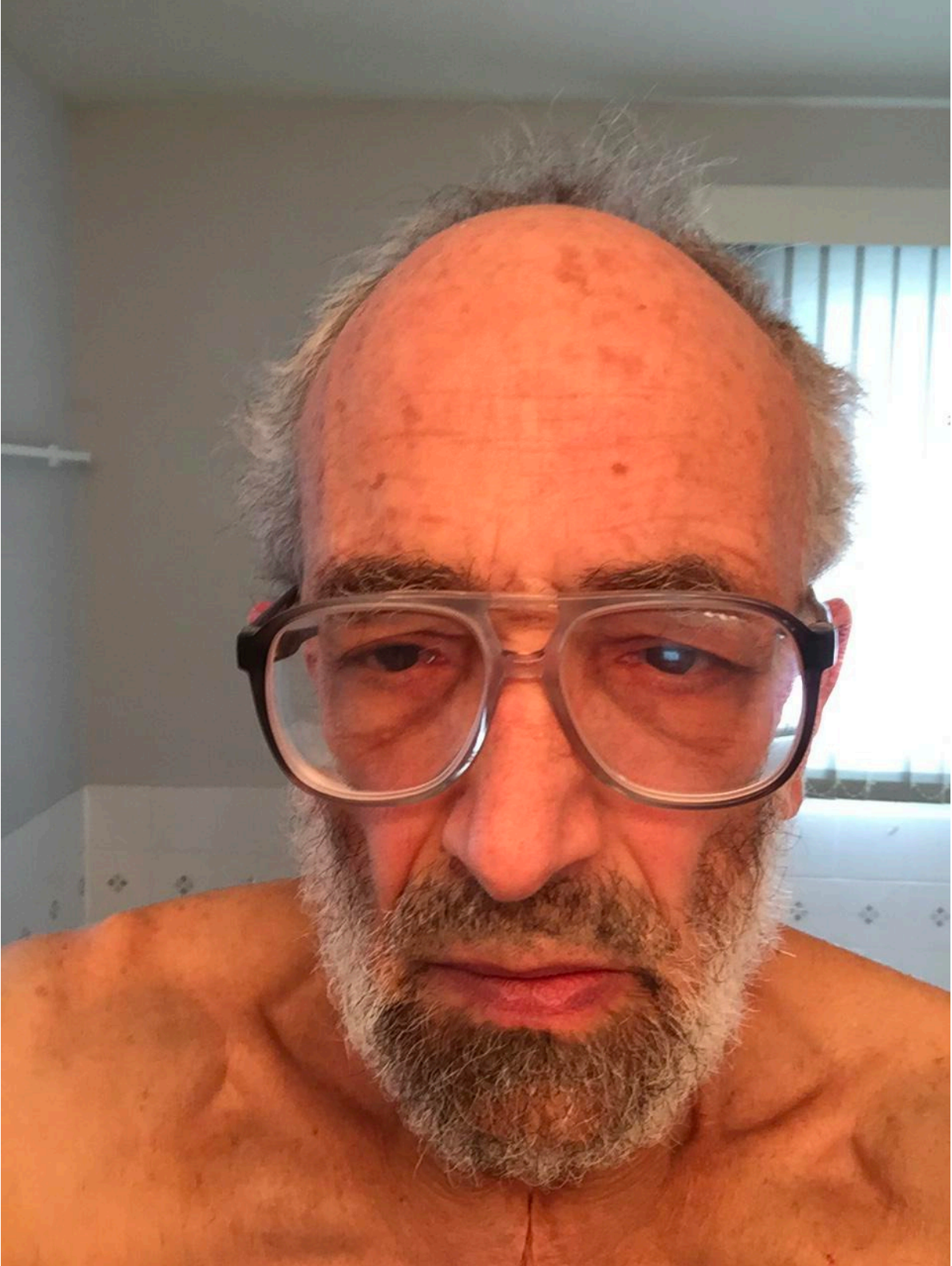
It Worked!!!

The self-administered haircut itself required 14 iterations and took about ½ hour altogether including the time to sweep up the fallen hair.

As shown by photos taken during the haircut and a video taken three weeks later, the haircut achieved what was finally required, ...
no less and no more!













CS445 / SE463 / ECE 451 / CS645
Software requirements specification
& analysis

My Self-Administered Hair Cut
During the Covid-19 Lockdown

Summer 2020

Daniel Berry