Switch Tops: Some Data

-ThereminGoat, 06/20/2020

Hey all, it's been a minute since the last document. While there are several reasons for this, with the main ones revolving around a crazy work schedule, I also chose to take a bit more of an involved approach to this document. Rather than choosing to simply do a regurgitation of a history or a review of something from The Vault, I wanted to kind of explore some anecdotes I've been noticing surrounding looseness in top housings. To do this, I've chosen to employ a survey in order to collect a wide scattering data to attempt to draw some trends from the responses given. That being said, I haven't seen an article like this done before regarding switches or really within the mechanical keyboard hobby as a whole. If it gets even half decent reception, I may be inclined to do something like this again in the future, so please do let me know what you think of the article after reading.

As well, since publishing the Beginner's Guide to Switches, I've been receiving yet evermore advice with suggestions on things I could try out for documents and different ways to analyze switches. To those of you who I have promised I would consider these suggestions, don't feel disheartened that I haven't implemented them yet – as I simply want to make sure I can get them perfected to my liking before trying to push them out into the world. In addition to letting me know of your thoughts regarding this analysis and my survey based studies, I would be interested in hearing opinions regarding the two following things which I have toyed with the idea of doing over the last month or so:

-1. A Switch Focused Podcast

Due to the sheer time requirements for fully writing and polishing a document prior to posting, I tend to choose topics which have a good story and/or have a lot of interesting points to talk about. However, this does leave a lot of smaller "one-off" details that I would like to discuss with the world that simply don't have enough substance to make into a document. My idea for this would be something simple, akin to a half hour podcast of me effectively 'talking to the wall' each week of just things that I find interesting, annoying, or nice tidbits to know about switches. This will be much more prone to rants than text, as well, which I've found some people enjoy from time to time.

-2. One Page Switch Summaries

Unfortunately, there are a lot of people in this hobby that seem to have short attention spans. While this is mostly a joke, there is a push from a fair amount of people within the community for instantaneous reviews and numerical scores for switches, such that they can spend less than 30 seconds on a review to get 'an opinion'. By and large, I dislike this model because I feel like it encourages people to simply go "Goat gave it a 65/100, therefore it's not worth my time" when I may think that there is actual useful qualities or niche aspects about the switch that are worth knowing about and potentially using in a build. However, I can't do a review of all 700 of my switches in any sort of reasonable time frame. Thus, I've been toying around with the idea of making a "1 page summary" stat-style sheet database where I can much more easily cover switches that I wouldn't otherwise touch. As well, this solution should be easily modifiable in the future when I choose to go through and "readjust scores". Alongside my rationale above for not wanting to give numerical scores in reviews, I have always been worried about "score creep" in which my scores continually get better and better over time without readjusting the baseline for what is sufficient, good, excellent, etc., and this format may be a quick way to remedy that in the future.

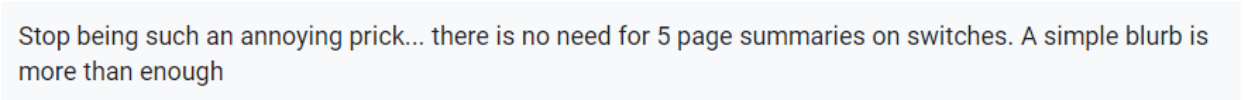


Figure 1: At least this one had the attention span to fill out the survey for this document and leave a comment. Made this one extra-long for you, buddy. - XOXO Goat

Switch Tops and Looseness

Over the last few months within the mechanical keyboard scene, I've begun to notice a rise in the usage of switch films putting them to almost a "must have" addition to any switch modification alongside lubing of switches. That being said, I haven't actually seen some solid rationale for *why* this trend is occurring. The few scraps that I was able to pull together from looking further into the matter is that films are being more frequently referenced as being used to 'change the sound' of a switch in a final build. While I certainly won't argue that they *wouldn't* change the sound, I know that this wasn't the initial use-case of films when they were first introduced nor the rationale, I have in mind for using them.

While I can't pinpoint an exact date as to when films were first introduced into the hobby, searching through the related subreddits and forums makes it appear that they were used at some capacity in early 2018 at least. However, reading most of these threads through, it appears that the use-case for them was centered around a reduction in the wobble of switch top-housings. Thus, due to the relatively tight tolerances of everything being produced on the market at the time, as well as there just being significantly less switches being produced, switch films didn't seem all that popular. However, over the recent few months there has been an absolute surge in their usage, including in switches that were previously deemed fine without films. As well, there has been a huge spike in the variations in film thickness, material, and type, with the market expanding to meet demand.

Figure 2: Maybe I'm behind the curve, but I don't even know what "gasket" films are.

Fully realizing this trend, I began to become curious if there was some growing necessity to films other than for the more common modern use-case in modifying the sound of switches. Certainly I have not recognized a significant increase in switches with naturally loose top housings, with the only ones even remotely coming to mind being Okomochi and FFF switches – which were both limited run Durock/JWK "clones" from their early days on the scene. Through discussions surrounding this uptick in usage, I came across the increasingly popular opinion that films are necessary for switches after opening to lube them as something about the process of opening causes the plastic in the top housings to not quite return to the way it previously was. Not particularly noticing this trend myself, and having lubed thousands of switches on my own time, I began to form some ideas to maybe explain why switch tops are more loose after opening them to make modifications. And this is where it has brought me.

The Survey

Rather than first introducing my ideas as to *why* I think switch tops may be becoming loose after opening for modifications, and thus driving the uptick in usage aside sound-based reasons, I am going to choose to present the data first and some of the trends I discovered prior to speculation.

In order to try and determine if there was something about opening switches that caused top housings to wobble more after reassembly, or if there was even a trend to recognize at all, I conducted a randomly distributed survey with ten questions focusing on random mechanical keyboard enthusiasts' experience with lubing switches and subsequent top housing wobble. Several points of data regarding user behavior were collected including the following:

-Number of times having previously lubed switches
-Number and types of brands having previously lubed
-The process by which the switches were lubed

This was then paired with user experience data, which was also collected, including the following:

-A determination of if they had noticed switch top-housing wobble after lubing and reassembly
-A percentage of switches affected by wobble if wobble was noticed

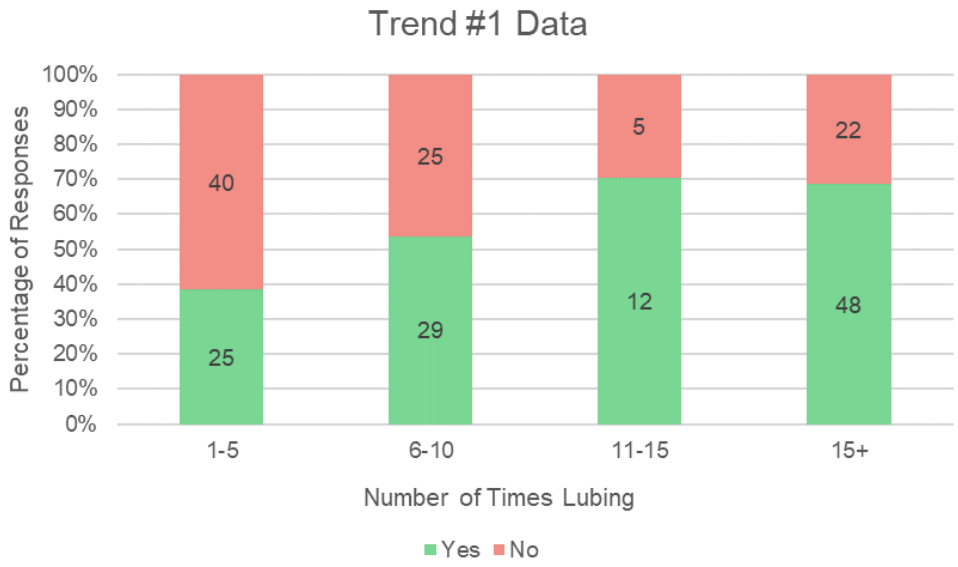
Given the results of the survey, which included 224 randomized participants with 205 having had lubed their own switches at least once prior, I then chose to do an analysis of the results to see if there were any noticeable trends between user behavior and user experience. An example of this would be analyzing the data to determine if the data suggests people who have lubed more times may notice switch top-housing wobble at a greater rate than those with lesser experience. From the data collected, there were several different trends analyzed which I will discuss below.

Also, worth noting here is that not all data collected in this survey was used in this document nor deemed significant enough for me to share. Aside being how most scientific studies based around survey data are conducted, this was done to simplify and shorten (ha) the document. Whenever user behavior and experience data will be discussed in the following sections, I will be sure to include the question corresponding to the data being discussed as well as the response options. A link to the survey will be included in the "Further Reading" section, with entries enabled in order to the questions to still be able to be read, but no further analysis of the data will be completed or included.

As for the more technically minded people who want to understand where I determined these conclusions from, I ran several different combinations of user behavior and user experience data through ANOVAs, or Analysis of Variance tests using the statistical analysis platform JMP. With an alpha setting of 0.05, all of the ANOVAs were run with a null hypothesis of the selected user behavior having no significant effect on the selected user experience, with the alternative hypothesis stating a significant effect of user behavior on user experience. An alpha result of less than 0.05 was required to deem a significant effect between the user behavior and experience. While I recognize that this is not the most thorough stats based analysis that I could have chosen to do, I felt that this was an appropriate level of introductory analysis to prompt further investigation if the results were interesting or generated enough discussion. As well, I chose to present the data in plain graphs and comparisons, where possible, rather than consistently invoking statistical analyses to help simplify the data for the average reader (who did not suffer through a statistics class like myself).

The Results

Trend #1: Correlation between number of times having previously lubed switches and experiencing loose switch top housings.



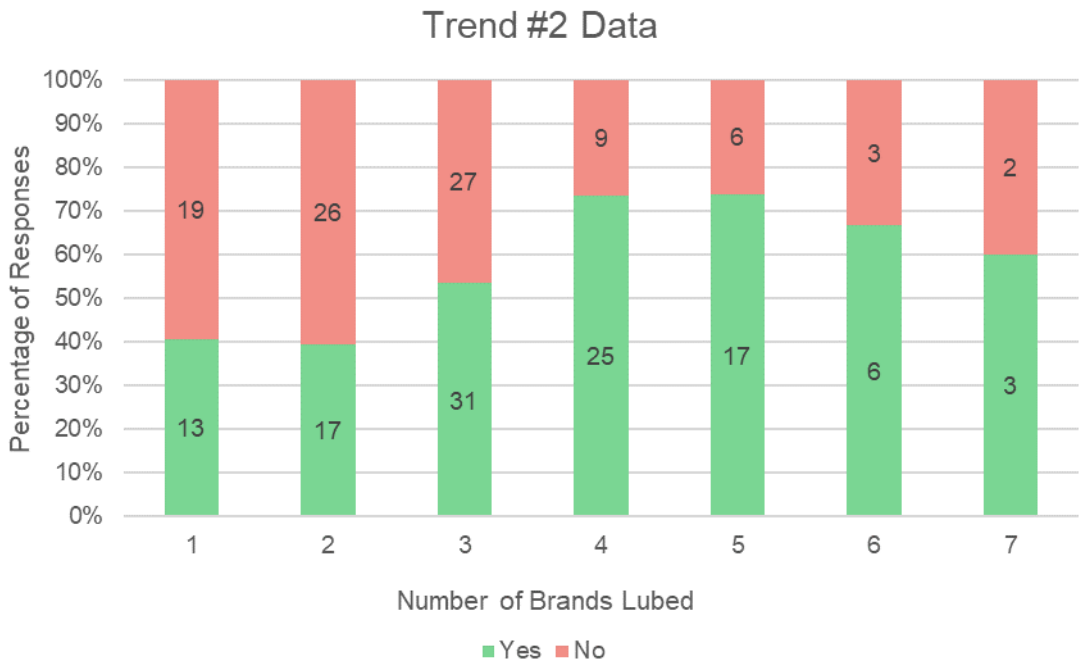
The first trend of the data explores the correlation between the user behavior of number of times having previously lubed with the user experience of noticing wobble in the top housing of a switch after lubing. The following questions from the survey were used in this data analysis:

#2. How many times have you lubed a pack of 10 or more switches?
Answers were binned as 1-5 Times, 6-10 Times, 11-15 Times, and Greater than 15 Times

#5. Have you ever noticed any looseness in the top housings after assembly of your lubed switches?
Answers were a simple ‘Yes’ or ‘No’.

As can be seen from the data simply, as well as in the statistical analysis that was conducted, there was a significant correlation between the number of times having previous lubed and the likelihood to notice wobble in the top housings after reassembly. These results may suggest that the more often you lube switches, that you might be more inclined to notice switch house top looseness afterwards. These results, on their own, are not necessarily indicative of a pattern so further discussion of this data will be continued in the following sections.

Trend #2: Correlation between number of brands having previous lubed and experiencing loose switch top housings.



The second trend of the data explores the correlation between the user behavior of number of brands having previously lubed with the user experience of noticing wobble in the top housing of a switch after lubing.
The following questions from the survey were used in this data analysis:

#3. What brands of switches have you lubed before?
Answers were given as a multi-select of various brands and were then converted into a numerical answer.

#5. Have you ever noticed any looseness in the top housings after assembly of your lubed switches?
Answers were a simple ‘Yes’ or ‘No’.

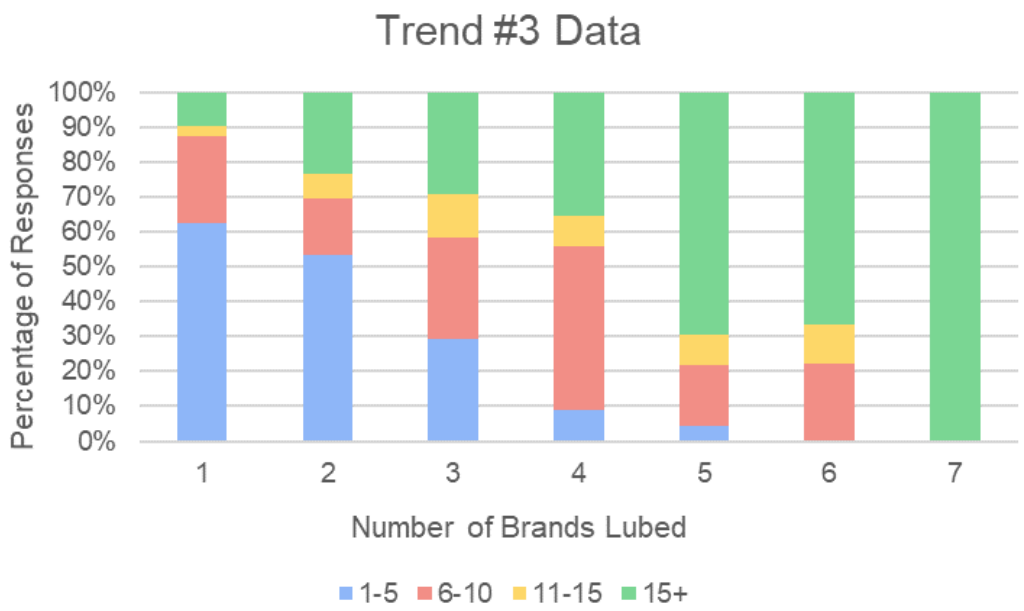
Much like the data seen from Trend #1, this data also simply demonstrates that there is a significant correlation between the number of brands having previous lubed and the likelihood to notice wobble in the top housings after reassembly. (This was also supported by statistical analysis, which deemed that the number of brands lubed had a significant effect on the likelihood of noticing loose top housings in reassembled switches.) This is especially noticed in the jump between 3 and greater numbers of brands. Obviously, this trend makes sense when considered alongside the first trend discussed as many people would assume that as you lube more switches that you would be more likely to explore different brands.

The reason that this was explored as a trend was due to the implication of a ‘not significant’ correlation between the two would have rendered quite interesting results. Finding a lack of a significant correlation between these two sets of data could potentially imply that one particular brand was worse than others for looseness after reassembly, as further exploration in brands past that one would not see a significantly greater exposure to loose top housings than this one particular problem brand.

Again, kind of like with Trend #1, this correlation really only sets the stage for further trends discussed below with more interesting results. The reason that I chose to include these trends are that they serve as a

great benchmark to show that the data collected is already agreeing with what I would imagine as commonly guessed trends, and thus supports that further, less obvious trends are still reasonable.

Trend #3: Correlation between the number of times having previous lubed and experiencing loose switch top housings.



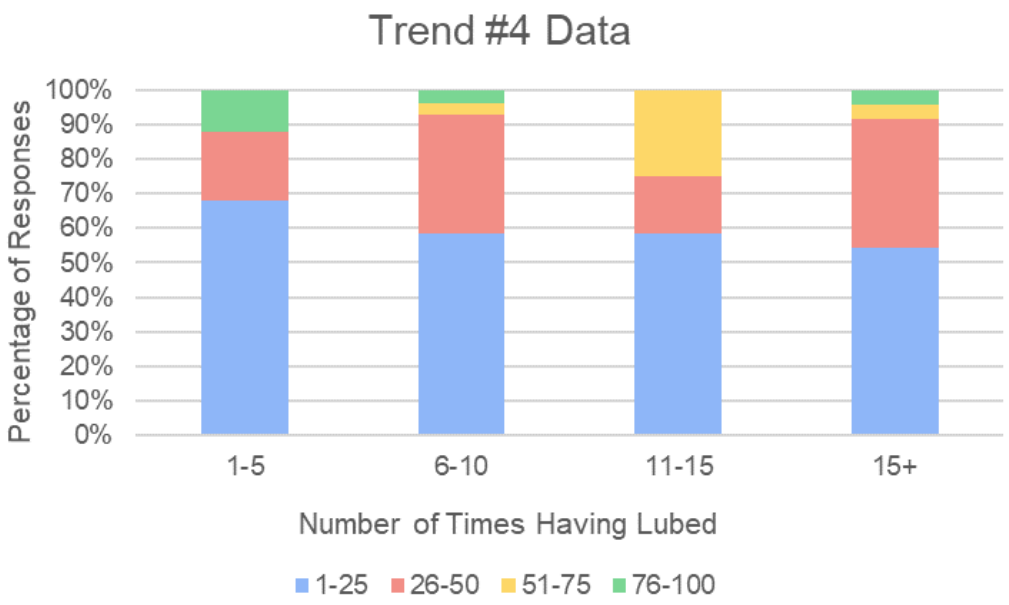
The third trend of the data explores the correlation between the user behavior of number of brands previously lubed with the user behavior of number of times having lubed.
The following questions from the survey were used in this data analysis:

#3. What brands of switches have you lubed before?
Answers were given as a multi-select of various brands and were then converted into a numerical answer.

#2. How many times have you lubed a pack of 10 or more switches?
Answers were binned as 1-5 Times, 6-10 Times, 11-15 Times, and Greater than 15 Times

As can be seen in this data, there is a significant effect of number of times having lubed with the number of brands having been lubed by the user. This trend was discussed as an extensive observation of Trends #1 and #2 above, but this trend was analyzed in order to, again, verify the consistency of the data with expectation.

Trend #4: Correlation between the number of times having previously lubed and the percentage of switches noticed loose, if loose switches were noticed.



The fourth trend of the data explores the correlation between the number of times having previously lubed switches and the percentage of switches noticed as being loose after reassembly if loose switches were noted.
The following questions from the survey were used in this data analysis:

#2. How many times have you lubed a pack of 10 or more switches?
Answers were binned as 1-5 Times, 6-10 Times, 11-15 Times, and Greater than 15 Times

#6. On approximately what percentage of switches would you estimate the looseness of the top housings were?
Answers were binned into ranges of 25% for four answers. (1-25%, 26-50%, 51-75%, 76-100%)

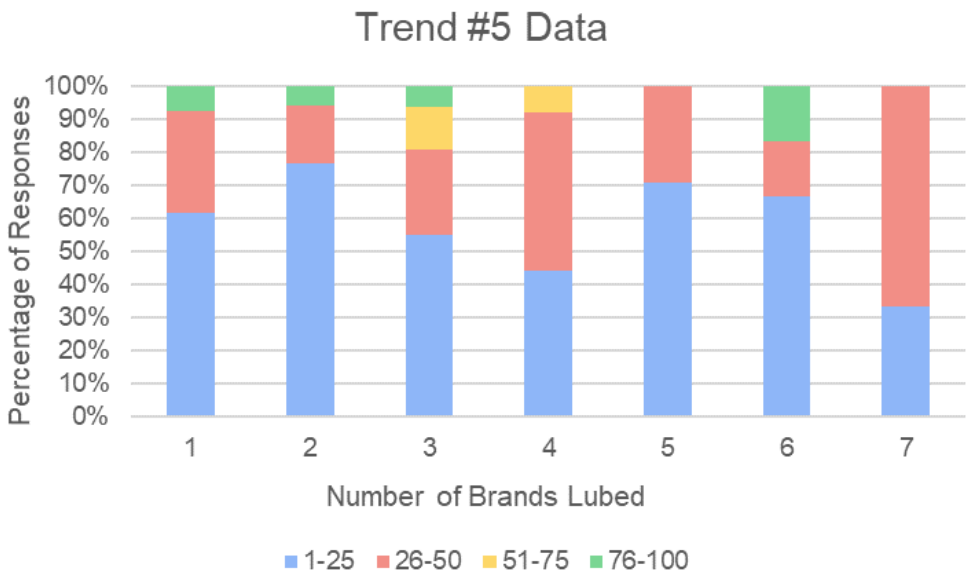
Trend #4, unlike the previous three mentioned, is where more interesting results began to appear from the analyses conducted. As you may be able to interpret from above, there does not appear to be any significant effect of the user behavior of prior lubing experience on the user experience of loose switch top housings. While no real interpretations of the implications of these results have been discussed yet for any trends, this lack of significant correlation (which was verified as not a significant effect using statistical analyses) weakens two assumptions about the noticed phenomena of loose switch top housings after reassembly:

1. This trend may suggest that there is some weakness to the idea that it is “all in your head” and that it is only noticed by people who lube a lot and are extremely picky. If one were to make the assumption that people with more experience lubing would be more inclined to notice looseness, then we would expect that experience would have a significant effect on the percentage of switches that someone would deem as loose due to their more particular tastes.

2. This trend may suggest that there is some weakness to the idea that switch top housing looseness is a result of some behavior by the individuals lubing. In the opposite direction from the first

assumption weakened by this lack of a correlation, one would anticipate that if there was some 'user mistake' that occurred leading to a loose switch top housing as a result of damage, that it would be more likely to occur with people with lesser experience and thus they would experience more 'defective' switches. Though, again, there appears no correlation between amount of loose top housings noticed and user experience.

Trend #5: Correlation between the number of brands having previously lubed and the percentage of switches noticed loose, if loose switches were noticed.



The fifth trend of the data explores the correlation between the number of brands previously lubed and the percentage of switches noticed as being loose after reassembly, if loose switches were noted.
The following questions from the survey were used in this data analysis:

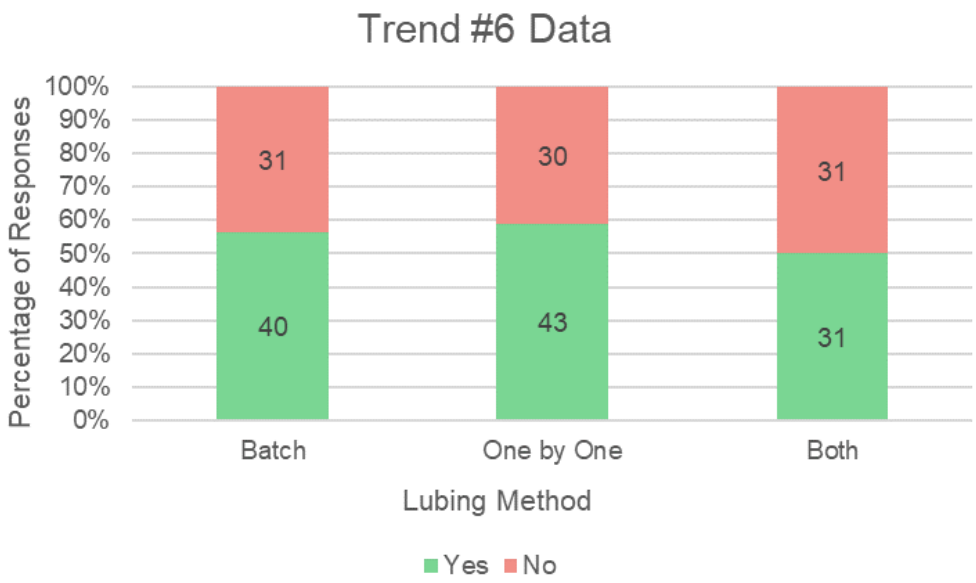
#3. What brands of switches have you lubed before?
Answers were given as a multi-select of various brands and were then converted into a numerical answer.

#6. On approximately what percentage of switches would you estimate the looseness of the top housings were?
Answers were binned into ranges of 25% for four answers. (1-25%, 26-50%, 51-75%, 76-100%)

Trend #5 was analyzed and found both by sight as well as by statistical analysis to show that there is not a significant correlation between the number of brands previously lubed and the percentage of switches that were noticed as having loose top housings after reassembly. This was mainly reported to support Trend #4 as well as verify between these two trends the same reasonable assumptions concluded from Trends #1-3, in which a greater number of times having previously lubed would likely lead to a greater exposure to different switch brands. As well, this further weakens the assumptions outlined in Trend #4.

The fact that Trends #4 and #5 are demonstrating that there is likely not a significant effect of experience (or lack of experience) on the presence of loose switch housing tops after reassembly begins to suggest that this experience is as a result of some external effect and is *not* the result of user behaviors being studied in this survey. While you could surely open a switch top, bash its legs against a table, and then attempt to reassemble it resulting in a loose switch top housing, it doesn't appear that normal modification behavior, such as lubing switches, is leading to this effect.

Trend #6: Correlation between the method used in lubing switches and experiencing looseness in switch top housings.



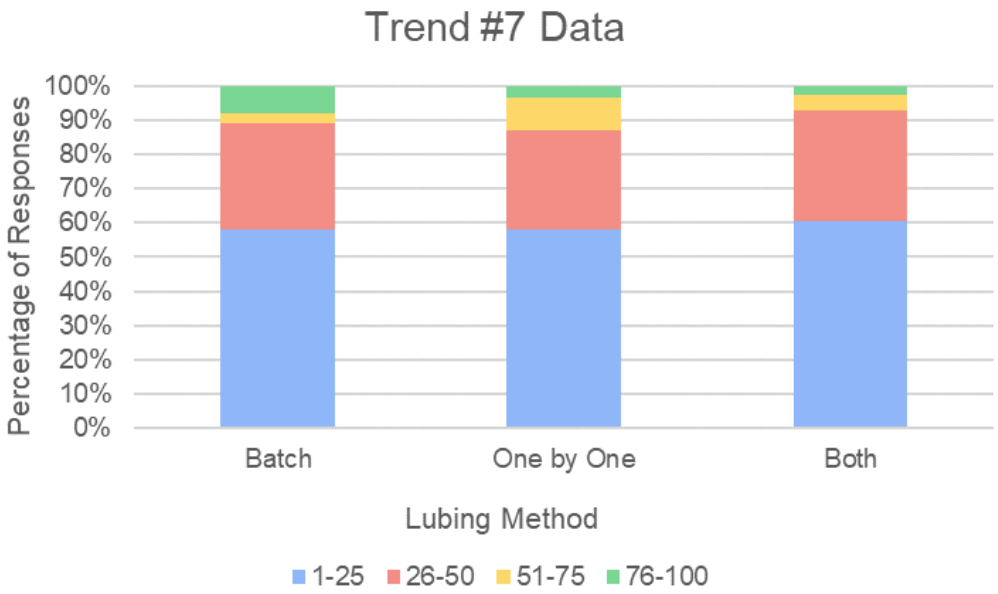
The sixth trend of the data explores the correlation between the lubing method used and if looseness was noted in the top housings of switches after reassembly.
The following questions from the survey were used in this data analysis:

#3. Did you lube your switches one-by-one or in a batch process? In this instance, batch would be separating all of the switches into different piles and then lubing and reconstructing them together. Answers were provided in as one-by-one, batch, and both.

#5. Have you ever noticed any looseness in the top housings after assembly of your lubed switches? Answers were a simple ‘Yes’ or ‘No’.

In order to further strengthen the claim that user behavior likely does not have an effect on the appearance of loose top housings, Trend #5 was explored to directly target if a specific lubing method caused more loose top housings than others. In this, the two methods explored were Batch and One-by-One, in which batch lubing is represented by the disassembly of all switches, placement of parts into a pile, and then lubing and reassembling them one by one. One-by-one method, on the other hand, saw the disassembly, lubing, and reassembly of each switch separately. As can be seen in the data above, the ratios of ‘did’ to ‘did not’ notice loose top housings are almost equal across all methods. This was further verified by statistical analysis which confirmed that lubing method did not have a significant effect on whether or not switch top housings were noticed as loose.

Trend #7: Correlation between the method used in lubing switches and the percentage of switches noticed loose, if loose switches were noticed.



The seventh (and final) trend of the data explores the correlation between the lubing method used and the percentage of loose top housings noted in switches after reassembly, if looseness was noted.
The following questions from the survey were used in this data analysis:

#3. Did you lube your switches one-by-one or in a batch process? In this instance, batch would be separating all of the switches into different piles and then lubing and reconstructing them together.
Answers were provided in as one-by-one, batch, and both.

#6. On approximately what percentage of switches would you estimate the looseness of the top housings were?
Answers were binned into ranges of 25% for four answers. (1-25%, 26-50%, 51-75%, 76-100%)

Much like with the Trend #4 and Trend #5 connection, Trend #7 was analyzed and reported purely to further verify the claims suggested in Trend #6. As can been seen in the table above and verified using statistical analysis, there was no significant correlation between the percentage of switches noticed as having loose top housings and the lubing method used. This further supports the idea that the switch top housing looseness is not an effect of something that the user is doing.

Interpretation of the Results

If you've made it to the other side of that data, you can breathe a deep sigh of relief and know that at the least this section will not be so technical. That being said, typically statistical analyses of data are done with extremely precise language such that almost every sentence includes a form of 'may', 'maybe', 'likely', etc. as to not imply absolutes in the data. This interpretation will likely (ha) not be 100% faithful to the language of a statistical analysis purely for readability as well as ease of getting my points across. Feel free to meet me in the parking lot afterwards, you statisticians, if you'd like to fight it out.

Looking at the results of the survey I was surprised to find trends that suggest that the looseness noticed in top housings of switches is not a function of either experience or the style of lubing that takes

place. Trends #1-3 appear to simply confirm expected behaviors from the survey data and the community at large – in which people who lube more often have more experience with more brands and thus notice the occasional loose top housing more often than people who have maybe only lubed a handful of times in their lives. Trends #4-5, however, appear to show that so called 'experts' who lube more frequently than others don't appear to notice a greater number of switches with loose top housings after a lubing session than those who don't. This immediately then weakens the idea that looseness in top housings is only a minor detail that 'ultra-picky' people who spend more time lubing obsess over, and thus see more often. This would indicate to me that it is more likely that switch top housing looseness is thus a phenomenon that occurs at random and is simply noticed more frequently by people with more lubing experience due to their more frequent lubing.

Further cementing the idea that the looseness in top housings is a randomized event free from influence by the people conducting the separation and lubing, Trends #6 and 7 were employed. These trends noticed appear to suggest that the lubing methods used do not correspond to an increase in top housings loose, on both an absolute and percentage scale. Combining this deductive reasoning with that from the first five trends, my final conclusions surrounding the data is that it appears to suggest the following about looseness in switch top housings after reassembly:

-1. It is a randomized event that is not more or less likely to affect someone based on skill level.
-2. It does not appear to be affected by the means by which switch lubing is done.
-3. Switch looseness, as a whole does not appear to affect large quantities of switches after reassembly.

My Theory on Loose Top Housings

So as mentioned towards the beginning of this document, as I began to discuss this increasing trend of switch film usage and loose switch top housings with people in the community, I had developed some sort of a loose idea as to why upon lubing and reassembling some switches that people are encountering *some* loose top housings. While obviously this survey couldn't possibly prove my theory correctly, I still feel the need to share it as I think it will drum up interesting conversation surrounding the topic.

The basis of my entire theory as to how you encounter loose top housings in some switches after reassembly rests under the umbrella of the famous manufacturing buzzwords of 'Six Sigma'. Six Sigma, for those of you who haven't been subjected to training on the topic, is effectively an organized mindset and planning system used by industries to help mitigate error in their production line and more finely control the quality of their product within a certain error bound or 'sigma'. Now while this is typically an entire course with several distinct facets to it, the idea of a "Control Chart" is where I'd like to place the focus as it is what inspired the theory.

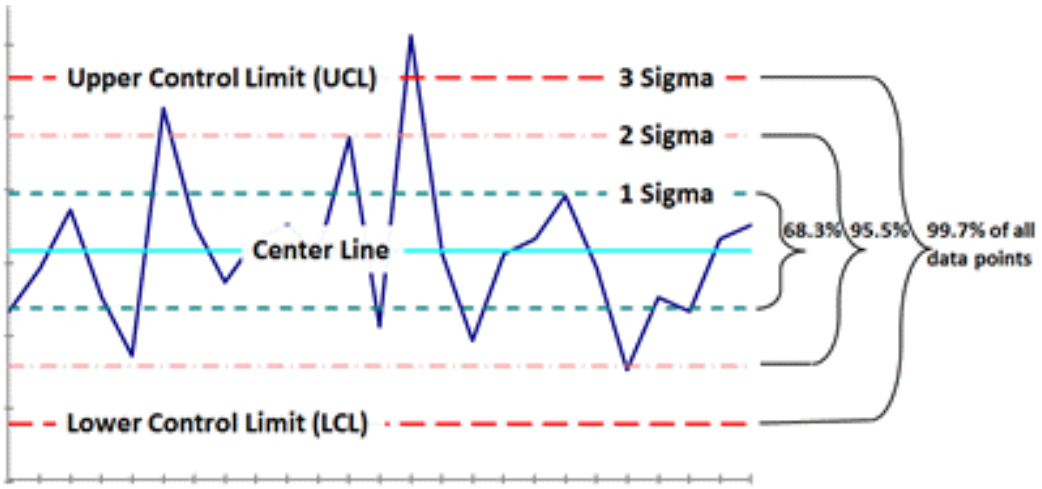


Figure 10: An example of a Six Sigma Control Chart.

Starting from the ground up, a control chart is used to track one facet of a product being manufactured – so let's use the squeakiness of a rubber duck as an example. Looking at dark blue, zig-zag line on the chart, imagine this as tracking the squeakiness of ducks as they come off of a production line – some of them being more squeaky than the target at the center line (closer to the Upper Control Limit), and some of them being less squeaky than the target and closer to the Lower Control Limit. In this graph, the Upper and Lower Control limits denote the absolute maximum and minimum squeakiness allowable, with anything outside of these bounds being products that need to be scrapped since they either can't be heard or break all glass within a mile radius. However, like with all products that are produced, there is *some* level of acceptable variance – and you can see three different levels here with the three sigma dashed lines in blue, orange, and red.

Extending this idea into switches, you can imagine much like our rubber ducks that there are going to be switch top housings that are slightly larger than the target size, and slightly smaller than the target size, yet still within the acceptable tolerances levels. The same thing would also apply for bottom housings of switches, as these too are put through a production process using a different mold. Since all of these pieces are within the tolerances, when the housings are assembled there isn't any noticeable looseness in the top housings for the majority of switches. However, with a little help in affecting the plastic of the top housings by opening them and then later reassembling them, my idea was that in batch lubing processes that one was more likely to create switches with a larger difference in tolerances than had already existed pre-assembled. To clarify a bit, considering the following example:

Switch XYZ has three tolerances for top housings and three tolerances for bottom housings:

- Large (Towards the Upper Control Limit)
- Perfect
- Small (Toward the Lower Control Limit)

Loose top housings can occur if the following pairs of top and bottom housings occur:
- Large Top and Perfect Bottom
- Large Top and Small Bottom
- Perfect Top and Small Bottom

There are 9 possible combinations of top and bottom housings.

If you were to have three switches with matching tops and bottoms (Perfect and Perfect, Large and Large, etc.) and then chose to scramble the top and bottom housing pieces at random, much like you would in a batch lubing process, you are more likely to end up with one of the three combinations mentioned above that would promote a loose top housing.

Obviously upon inspecting the data from the survey an interesting few piece of data are noteworthy when considering this potential scramble in housing pieces leading to more loose-top combinations. First, people are likely to immediately counter this theory with Trends #6 and #7 in which there was not a significant effect of lubing method, being in batch or one-by-one, on reported looseness of switches nor percentage of switches found loose. However, while this theory does primarily rely on a batch method to produce these loose-topped combinations, it has leeway with respect to this counter in that the survey does not take into account the fact that the opening of switches may alter the plastic enough to occasionally cause loose combinations – even in a one-by-one method where no scrambling occurs. Unfortunately, due to the fact that this is survey based data and no tests have been run to account for how repeatedly opening switches or on how opening switches by different means affects their looseness over time, this theory can't be discounted on the basis of Trends #6 and #7.

However, there is one piece of data from Trend #7 that does loosely encourage the possibility of this combination scramble leading to loose-topped switches. Considering the example used above with 9 possible combinations, 3 combinations at maximum could be used to create a situation in which the top housing is marginally larger than that of the bottom housing. One could further even argue that one of the combinations (Perfect Top/Small Bottom) may not even have a significant enough difference to produce a top housing wobble, and thus drop the possibilities down to two combinations. Regardless, the maximum number of switches then that one could expect to exhibit this behavior in a random sample would be no greater than 3/9 or 33%. In Trend #7, you will notice that roughly 90% of all responses for percentage of loose top housings after reassembly from all experience levels are 50% or less. Thus, with rare exception, if this theory were to hold true – it makes sense with the provided data and probability.

Regardless of whether or not this *is* an actual explanation for why roughly 1-25% of switches are found to be loose in the top housings after reassembly, I tried to base this theory in established production standards and techniques and had actually developed this idea prior to conducting the survey. Do I personally think that this is a super strong theory? No, rather I think it is a mildly supported (and interesting) thought experiment which could be a reasonable explanation for the trends noticed. That being said, I would strongly encourage the reader to develop their own interpretations of the data as well as apply their own ideas into maybe solving this mystery.

Final Thoughts

I mean, normally this section is a bit of a serious and less-than-lighthearted recap of the stuff discussed in the document, but given that this was a pretty dense article I'm probably just going to keep this easy on the brain. Overall, I think that the survey was certainly a success when it came to general responses from the public at large and definitely has me considering doing something of the sort again in the future if the response to this document is good. As well, I think that it was interesting to attempt to put some data and scientific analysis to the anecdotes floating around out there about wobble as there certainly is a lot of it to say the least. Regardless of the relative lack of impact of switch housing top wobble in the rise in usage of all of these switch films, I will always be happy to get to see more modifications making their way onto the main stream as I think it only benefits the customization aspect of switches further.

As well, I'd like to thank 'whydobearsxplod' for helping me mentally parse through the data and plot how I was going to go about presenting it. I really appreciated the late-night help.

Further Reading

Survey Used in this Document
Link: https://forms.gle/UWze6FbmeyqwwBHp7

Deskeys Gasket Switch Films
Link: https://www.primekb.com/products/deskeys-switch-films-1

Walker's Keyboard Science Switch Films Video
Link: https://www.youtube.com/watch?v=ndT_TTQLflI

:3ildcat's Switch Film Comparison Video
Link: https://www.youtube.com/watch?v=yZhEwYqJabw

Andy Nguyen's Switch Lubing and Filming Video
Link: https://www.youtube.com/watch?v=l8cogVsCmfo