Dutch Open Impressioning Championship 2022

CCBY4.0 Jan-Willem Markus, Toool NL

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1 Introduction

This is a report on the Dutch Open impressioning Championship at LockCon on the 26th of August 2022. This document is written to give insight and share lessons learned in the competition for sponsors and future participants. We will discuss the competition, measurements of the locks, and analyze competition statistics.

In impressioning, we open locks by making a functional key without knowing the bitting beforehand. We use the feedback from the lock. In short, a blank key is tested in the lock. When it does not open the lock, the binding pins will leave small marks on the blade of the key. The key is removed and inspected with a magnifier. On each mark, a small amount of material is removed with a file before the key is tested in the lock again. This process is repeated until the lock opens. For a longer explanation of impressioning, please see the chapters on impressioning in the book Locksport, published by No Starch Press.

The Dutch and German competitions are standardized to the Abus C83 in euro cylinder format (Not to be confused by the Abus 83 series padlocks). This lock is engineered to make impressioning as difficult as possible, with three types of security key pins. Abus kindly sponsored the locks for most Toool and SSDeV competitions, for which we are very grateful.

Please note, the participants have trained for the competitions and have practiced almost exclusively on the Abus C83. While the data is real, and this lock can be defeated by means of impressioning, the data is heavily biassed in favor of the competitions. Choosing a lock for your personal security has to have a balance between cost, key control, and resistance against destructive and non destructive attacks. The Abus C83 is a good lock, bit it does not feature high protection against destructive attacks as higher end models.

2 Competition rules

For the impressioning competition we optimize for opening the most locks in the least amount of time. Where reliable opens are valued over faster times.

Each participant brings their own impressioning equipment, including: impressioning handle, vice, magnification, and (Swiss cut) files. Some participants optimized their setups and bring workbenches and dedicated measuring equipment to the competition. We encourage optimization, but strive for a fair game. If you expect a technique or tool will give you an advantage, the tool and technique must be disclosed before the competition.

The basic rules for the competition are:

- Only the blank keys provided by the competition may be used during the competition.
- Only the key may enter the keyway of the lock. No Lockpicks or other tools are allowed in the keyway.
- Only the key may tension the lock. When the lock is mounted in a vice, the cam has to be free to move.
- The lock is open when the core is rotated with the impressioned key for at least 45 degrees. (Note, the competitions of SSDeV specify repeated openings and opening in both directions is required.)

The competition starts with a qualifier. Where each participant gets a keyed a-like Abus C83 lock, five key blanks, and one hour to open the lock. The fastest six fastest opens go to the A-finals, and the next six fastest go to the B-finals. Where the finals are ran with each finalist with one keyed different Abus C83 locks, and 15 minutes per round. After every round, the locks are swapped between the finalists. This process repeats for six rounds to give each finalist time with each lock. The finalist with the most opens in the A-finals wins the competition. Where the lower total time is the tie breaker.

Please note, while the competitions have been ran for over a decade with these rules, the details are subject to change.

3 Competition data

Before we preform the analysis we first need to share the competition data. We recognize the data set is small, but we are happy that we collected the key aspects. Including the locks, bittings, and opening times.

In the ideal world we would log more data, but we have to be realistic about what is possible. Both in time, equipment required, invasiveness, and usefulness. For example, we cannot analyze the locks themselves easily after the competition as each participant gets to keep the lock to practice for further competitions.

3.1 Qualifier

For the impressioning competition we set up the competition area after the morning talks. The venue has stage pieces, which we were allowed to use as sturdy tables. Setting up took more time than planned, which reduced the time for each participants practice session.

The qualifier round started with 35 participants. Of which, 24 opened the qualifier lock in under one hour. The opening times are: 2:05, 4:29, 5:34, 5:45, 8:35, 11:53, 15:18, 16:00, 18:22, 18:25, 19:40, 20:35, 21:07, 21:33, 21:33, 27:13, 29:02, 30:03, 31:56, 36:20, 39:25, 42:05, 47:32, and 54:58.

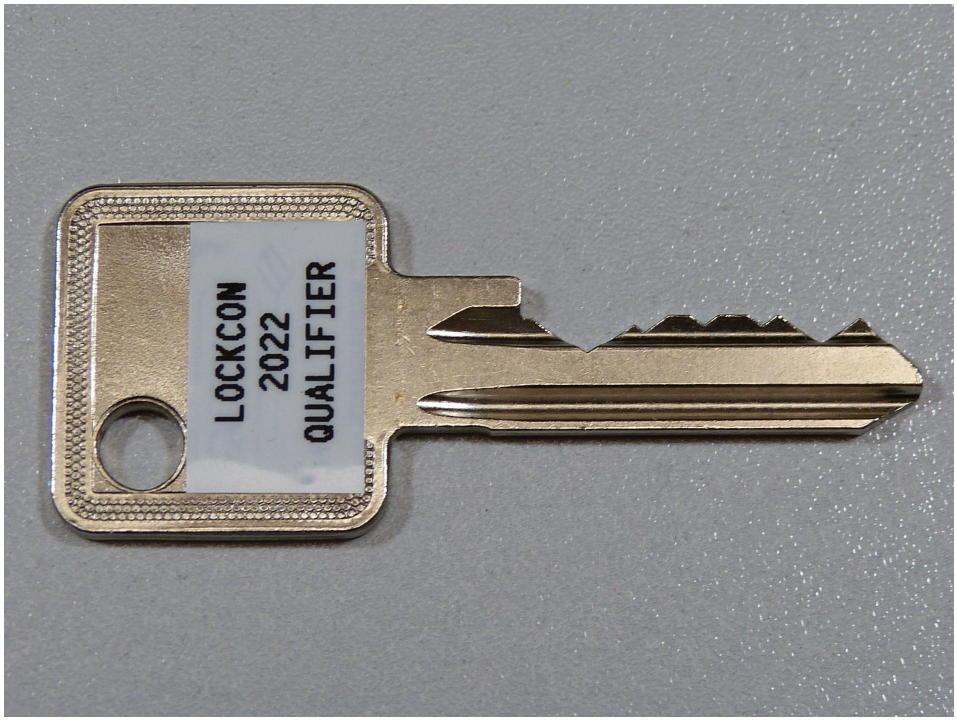


Figure 1: Key of the qualifier

The bitting of the key is revealed after the competition to be 62114, for a total of 14 cut depths and at most nine impressioning itterations.

3.2 A-Final

Figure 2: Keys of the A-Final

Key	Bitting	Cuts	1	2	3	4	5	6
A1	54385	25	4:02	8:28	-	-	-	-
A2	76477	31	-	-	12:43	-	-	-
A3	73852	25	-	-	-	-	5:37	-
A4	67356	27	-	-	-	-	12:57	-
A5	41263	16	8:29	-	7:47	3:42	-	-
A6	24638	23	-	3:42	-	-	-	-

In total 36 attempts are made over de six rounds, where the locks are opened in total nine times. We see some locks are opened more times than others. In particular the opens in round five are interesting, as already four rounds of fifteen minutes each was spent attempting to open the lock. The finalists opened each: 4, 3, 1, 1 0, 0 locks.

3.3 B-Final

Figure 3: Keys of the B-Final

Key	Bitting	Cuts	1	2	3	4	5	6
B1	47568	30	-	-	9:25	6:22	-	-
B2	41485	22	-	5:36	-	-	13:54	-
B3	46841	23	-	-	-	-	-	-
B4	73231	16	-	14:19	-	-	-	-
B5	76865	32	-	-	-	-	11:10	6:02
B6	68467	31	-	-	-	11:49	6:20	-

In total 36 attempts are made over de six rounds, where the locks are opened in total nine times. Most locks are opened two times, except B4 which was opened once, and B3 which was not opened at all. The finalists opened each: 4, 3, 1, 1 0, 0 locks.

Toool donated two locks to make the B-finals possible with six participants.

4 Lock analysis

We have several locks to analyze, of which multiple of the keyed a-like qualifier cylinders as well as one lock from the finals.

To understand the pins better, we will first introduce a set of Abus C83 reference pins. The first set is of the modern Abus C83, which is used in the Abus C83 from 2015 onward. This type is uniquely difficult to impression as there are three different pin shapes. The smallest pins are serrated, the middle pins are T pins, and the long pins are spools. Each type leaves different marks on the key. The second set is from an earlier Abus C83 without security features on the key pins.

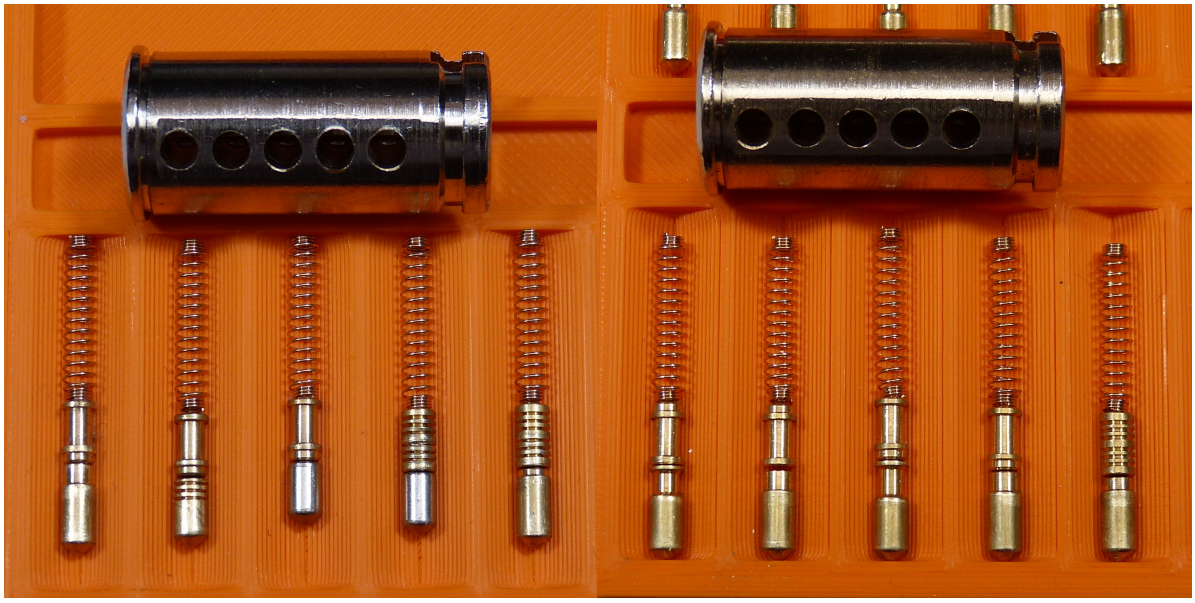
Figure 4: Reference set of pins. New pins on the left, and old pins on the right.

Abus uses a mix of silver, black, and brass colored pins in their locks. Where silver is presumed to tougher steel pins, and the black pins are cosmetic for differentiating sizes in pinning kits.

4.1 Locks

The qualifier lock, with key 62114, has a mix of pins with and without security features. For cut three and four, two silver colored pins without serration are observed. It is also noticable the core has significant forensic damage on chamber three to five. As well as a slight chamfer on the sheerline.

Of the finalist locks, we have lock B5 to analyze. The lock parts look good for a lock which has been impressioned for 81 minutes. The bitting of 76865 and shows all new style pins.



(a) Qualifier lock (b) Finalists B5

Figure 5: Core and pins of two competition locks

5 Analysis

The keyed a-like lock in the qualifier has shallower cuts than the locks in the finals. Where the qualifier locks are likely chosen by Abus to be easier. We determined the locks of the finals are stock by preforming statistical tests on the key bitting versus a collection of known bittings. Abus is well known for choosing keys with high bitting variance.

We observe a large time window between the opens in the qualifier. Where the large opening times are mostly due misreading the marks and removing too much material from the key. Once the key has been cut too deep it will no-longer open the lock. It takes the participants several more minutes to realize the key is not useful anymore. Where valuable time has been lost and a new attempt must be made from scratch.

5.1 Failed keys from the qualifier

We collected two samples of keys which failed to open the qualifier lock. The first example has been filed too deep on position three and four. The participant realized from the marks and the behavior of the lock that the key was filed too deep.

(a) Failed qualifier key (b) Broken qualifier key

Figure 6: Two key samples from failed qualifier opening attempts

The second sample is from a different participant. Where the key broke in the lock on a final attempt. The lock was swapped for a new lock after the competition. To remove the broken key the lock was cut in half. Also for this sample, the key was cut too deep cuts on position three and four.

Given the two samples show the same result, we believe the pins in chamber three and four cause different marks than the participants expected. By mixing old and new pins, and of different hardnesses, the pins resulted in different markings on the key in comparison to the locks the participants practiced on. We call these false marks as the filing results in a failed opening attempt.

5.2 Poldi hardness measurements of keys

Next to the false marks, several participants noted the blanks were softer than they expected. Where as other participants did not feel the difference in hardness. To understand the difference, we quantified the difference in hardness with a Poldi hardness measurement. Where from three boxes of blanks at LockCon 2022 we retrieved five blanks of each. The average BHN measurement came in as 127.4, 108.9, and 131.5 respectively. Where we concluded some blanks were, indeed, softer than others.

In a practice session we determined a skilled impressioner can feel the difference between the hardness of blanks when the blanks are switched mid session. But after using a mix of blanks, the advantage is lost.

The full explanation of the hardness measurement are found on the Toool Blackbag. https://blackbag.toool.nl/?p=4029

5.3 Comparison of locks between manufacturing dates

The Abus locks are continuously improved, this is remarkable as the Abus C83 is a low cost cylinder. We analyzed tens of competition locks of various ages and found the quality has improved. Looking at the core of the lock, we see a slight chamfer at the shearline. Where we expect this to aid in the smooth operation of the lock.

We found the chamfer on the cores of the 2019 locks to be slightly offset, and the chamfer to be less severe in locks at the 2022 completion. This likely aided in making the locks harder to impression.

(a) 2019 qualifier (b) 2022 qualifier

Figure 7: Comparison between the Abus C83 core of 2019 and 2022

6 Closing

We ran a successful impressioning competition at LockCon 2022. 35 people participted, of which 24 opened a lock within the hour of the qualifier. In the finals another eighteen opens are registered.

The times of openings vary wildly in the qualifier. Where the A-finals qualified with times from 2 minutes to 12 minutes, and B-finals qualifiers from 15 minutes to 20 minutes. Several participants which have been at the top of the game failed to open the lock in time to qualify.

Furthermore, it's clear we need to practice on a larger variety of pins and blank hardnesses. And reserve enough time for the participants to setup, acclimatize, as well as encourage to open at least one lock with the setup before the competition. The difference in atmosphere and lighting throws off your personal calibration.

We believe the skill we want to practice is opening locks consistently, instead of setting the best times. Therefore, we would like to experiment with the setup of the competition. For example, to run two qualifiers of 30 minutes each. Where the finalists are determined by most opens, and least combined time. To keep the effort for the finalists constant, the finals can then be reduced to five finalist each.

Toool has learned a lot from hosting the competition. We hope you've learned something from this report as well. Thanks, again, to Abus for making this competition possible.