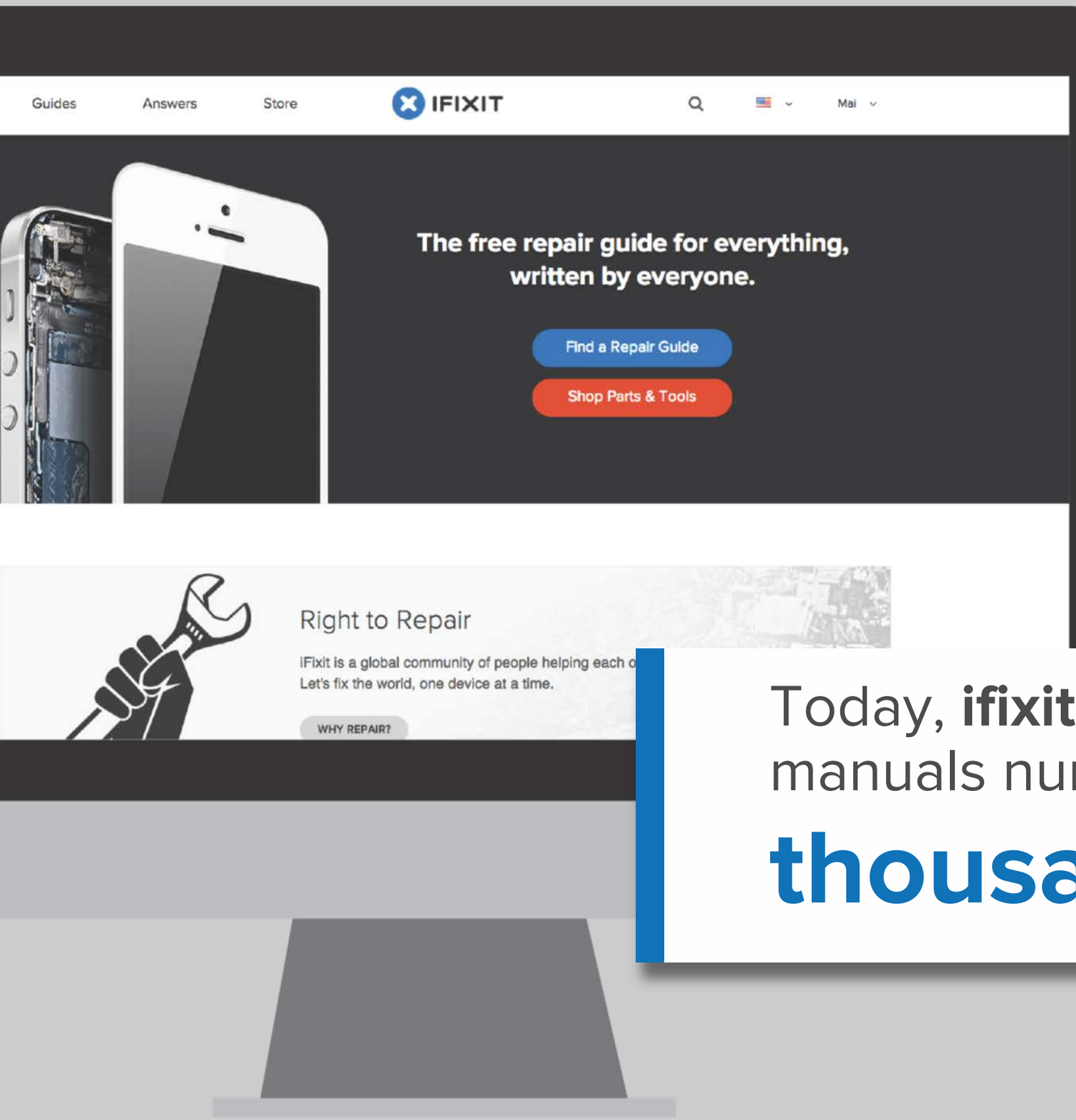
IFIXIT

Fixing the Scoring of Reparability

Repair 2.0
Learn from the world.



Today, **ifixit.com** hosts repair manuals numbering in the many

thousands

Apparel	Appliance	Camera	Car and Truck
Computer Hardware	Electronics	Game Console	Household
iPod	Mac	Media Player	PC
Phone	Skills	Tablet	Vehicle

Learn a new skill

View All >

Applying Thermal Paste

How To Solder and Desolder Connections

Testing Power Cord Continuity

Electronics Skills Kit 101

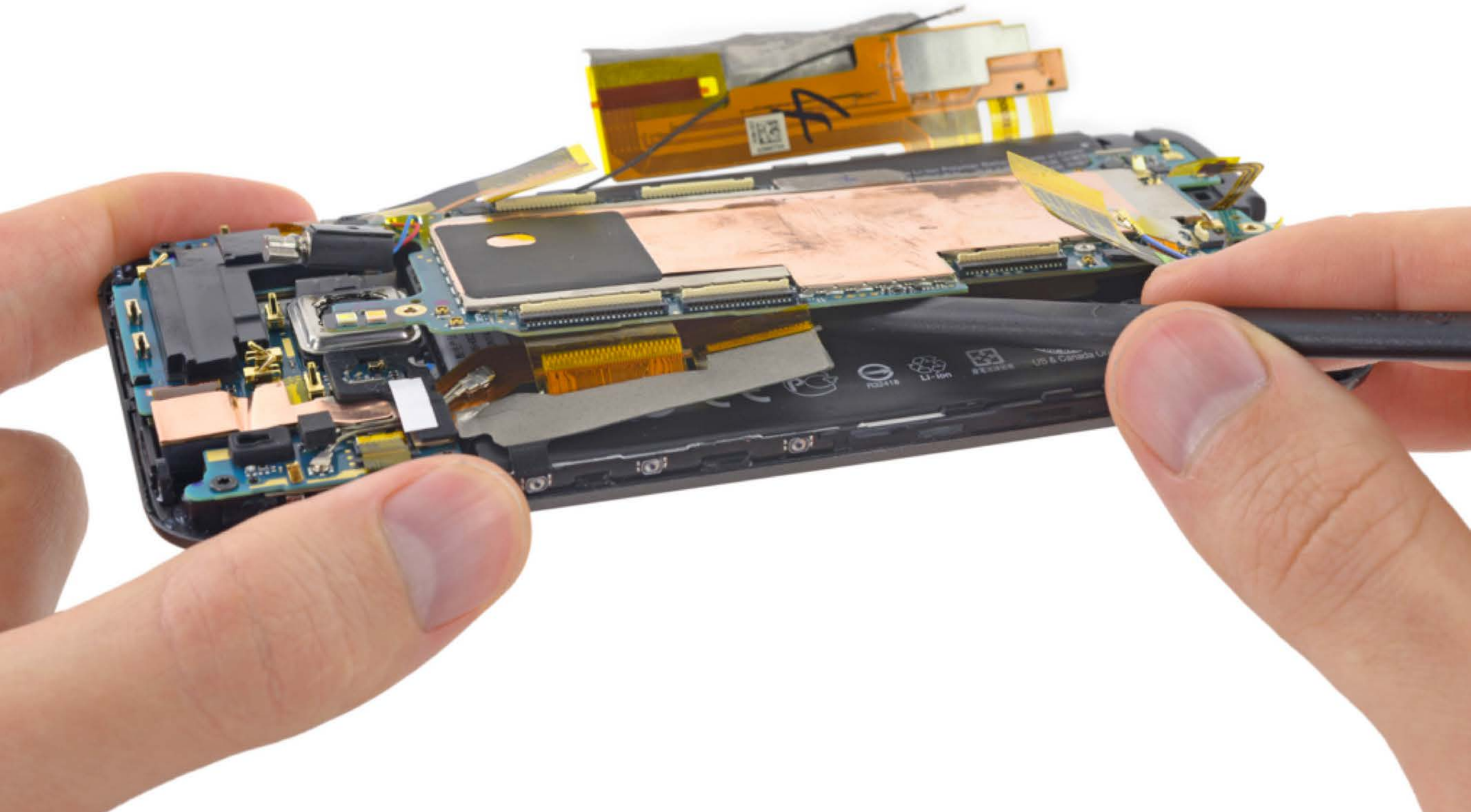
Thread a Sewing Machine

Sew a Button

How To Use A Multimeter

How to Take Awesome Photos

htc



htc

REPAIRABILITY SCORE:

IFIXIT

Smartphone Repairability

Our engineers disassembled and analyzed each smartphone, awarding a repairability score between zero and ten. Ten is the easiest to repair.

How we rate devices:

A device with a perfect score will be relatively inexpensive to repair because it is easy to disassemble and has a service manual available. Points are docked based on the difficulty of opening the device, the types of fasteners found inside, and the complexity involved in replacing major components. Points are awarded for upgradability, use of non-proprietary tools for servicing, and component modularity.

LG
G4
2015

- Rear panel and battery can be removed with no tools.
- Many components are modular and can be replaced independently.
- LCD is fused to the glass.

8

Google
Nexus 5
2013

- Modular design allows replacement of individual components.
- Standard Phillips screws used throughout.
- LCD is fused to the glass.

8

Samsung
Galaxy S4
2013

- Battery is easy to replace.
- Very easy to open for access to internal components.
- Components adhered to the back of a fused display assembly.

8

Blackberry
Z10
2013

- Battery is easy to replace.
- Standard screws make the device easy to open.
- Smaller components are strongly adhered in place.

8

Samsung
Galaxy Note II
2012

- Battery is easy to replace.
- Very easy to open for access to internal components.
- Components adhered to the back of a fused display assembly.

8

Amazon
Fire
2014

- External, non-proprietary screws make getting inside straightforward.
- The four Dynamic Perspective cameras are encased in glue.
- The phone is not modular, increasing the cost of replacement parts.

3

HTC
One M9
2015

- Standard Phillips screws make the rear case easier to open.
- The display assembly is the hardest component to replace.
- Battery is buried under motherboard and adhered to midframe.

2

HTC
One M8
2014

- Standard Phillips screws make the rear case easier to open.
- The display assembly is the hardest component to replace.
- Battery is buried under motherboard and adhered to midframe.

2

Apple
iPhone
2007

- Standard Phillips screws used throughout.
- Hidden clips make it nearly impossible to open rear case without damaging it.
- Soldered battery is very difficult to replace.

2

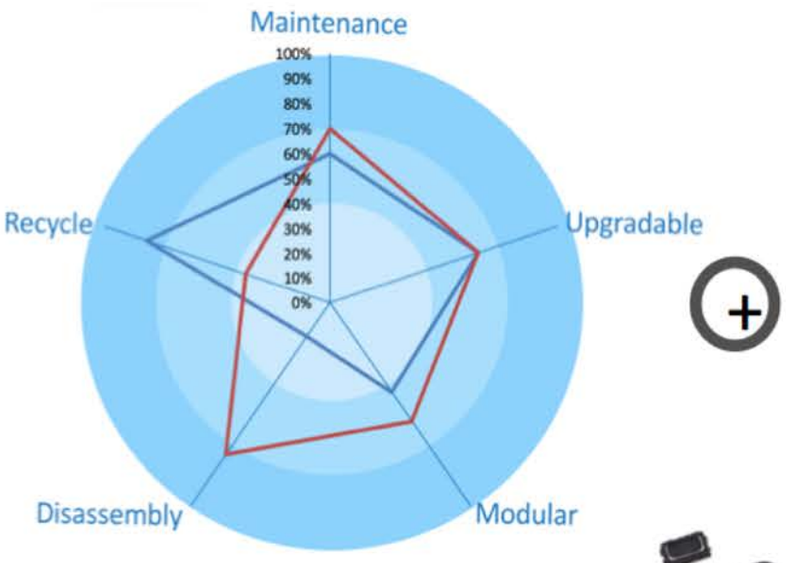
HTC
One
2013

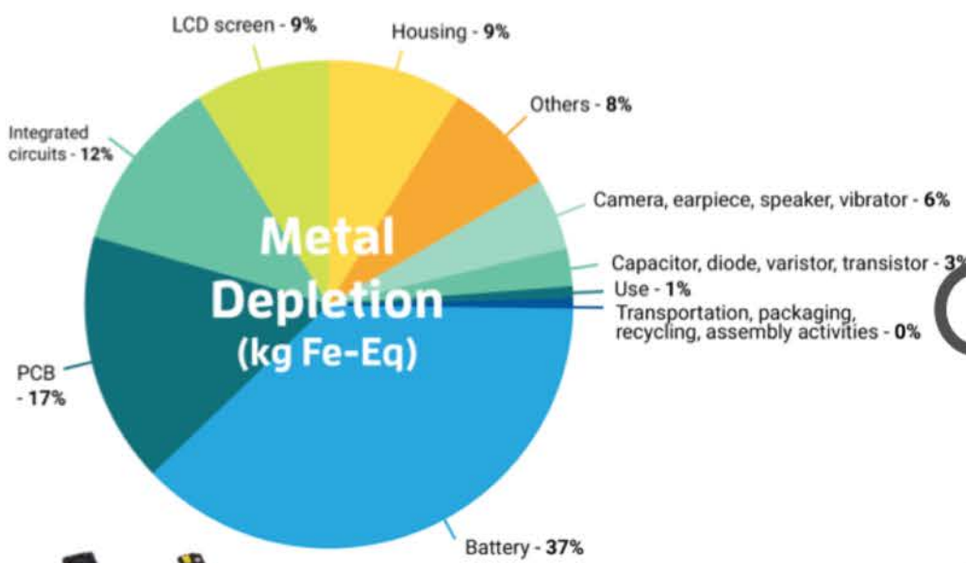
- Solid external construction improves durability.
- Virtually impossible to open without extreme damage to rear case.
- Battery is buried under motherboard and adhered to midframe.

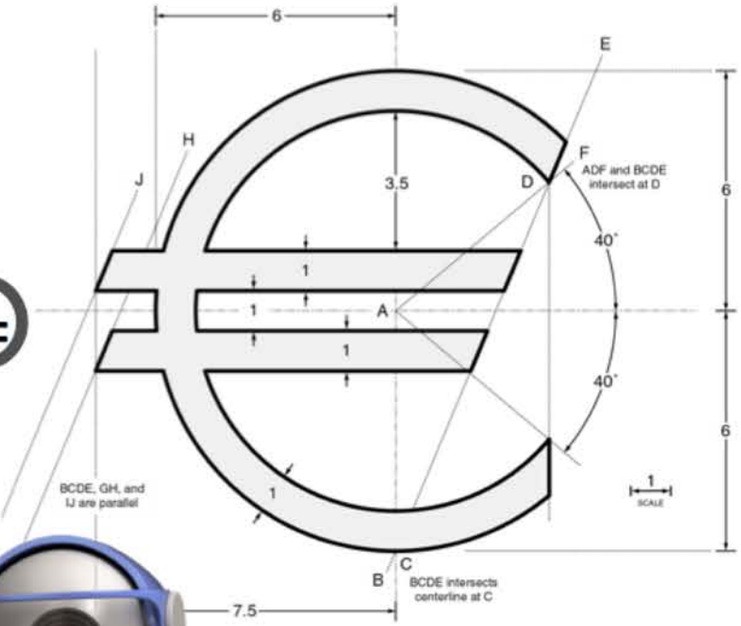
1

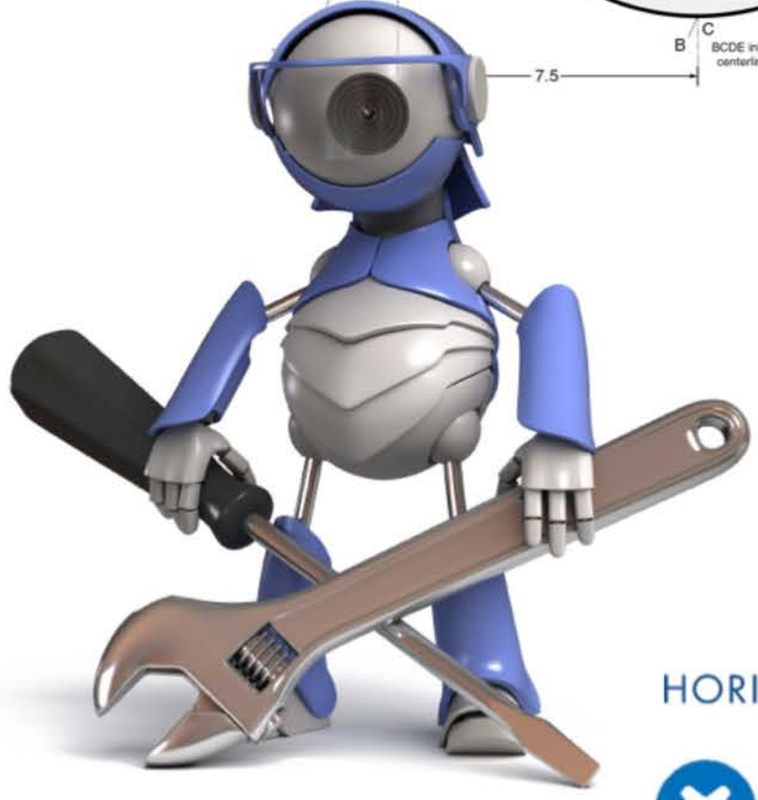
EU Grant Project

sustainablySMART









HORIZON 2020

IFIXIT

Project Objectives

Our task: To develop a validated reparability scoring system

- SustainablySMART will incentivize and advocate for design for repair / reuse / remanufacturing
- Repair, reuse and remanufacturing require basically the same design features
- We'll develop a system of algorithms to allow for a reproducible ranking of mobile devices in relation to these objectives
- The results will be communicated to policy makers and are intended to be reflected in eco-labelling

This project has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 680640 and 730308

Repair Scenario Considered

- Target audience: self-repair / laypeople
- Part replacement, not part repair
- Diagnosis is out of scope
- Critical components are accounted for
- Results must be stable over time

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Selection Principles for Criteria

Relevance (does the criterion address an essential aspect influencing the likelihood of repair in scenarios considered? Is the criterion the only/best one to address said aspect i.e. if we dropped this criterion, would we miss this essential aspect?)

Feasibility / objectivity / repeatability of verification (can we define the criterion in such a way that it can be assessed in a reliable and consistent way regardless of the person conducting the assessment?)

Potential for differentiation between products ('minimal pair': is there a series of relevant products i.e. smartphones or tablets currently on the market or expected to hit the market in max. 2 years, whose varying levels of reparability can (only) be distinguished by this criterion?)

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Selected Criteria / Rationale

SUSTAINABLY SMART

1 — Availability of information (Q)

Repair guides or service manuals ensure reliable ways of repairing the product for all potential repair actors. Having access to repair information reduces the risk of repair failures and thereby also increases the likelihood of the repair being undertaken, since fear of breaking a product decreases when a manual is available.

2 — Deterrent Messaging (Q)

Voiding warranty or other issues that disincentivise opening up a product stand in the way of actually repairing and thus extending the product life.

3 — Path of Entry (EoD)

Before initializing a repair process, the repairer should be confident that it is possible to finish the repair successfully. Whether the product itself encourages or discourages the repairer to open the casing (how daunting is it to open up the product) is therefore a determining factor for the likelihood of repair. The assessment focuses on the ease of opening up the exterior (the amount of force) and the tools needed to do so (from fingers only to the use of uncommon tools).

4 — Visual Cues (Q)

Visual mapping and identification of the components (e.g. battery), its fasteners (e.g. screws) and cable connectors (e.g. ZIF) by means of codes, icons or colour could help the repairer to initiate and run through the process of disassembly with more confidence. It also reduces the chance of overlooking fasteners or connectors and therefore improves tha chances of success.

5 —Spare part availability (Q)

Without critical spare parts, it is impossible to repair a product and bring it back to working functionality. Critical components can be made available to the general public for DIY repair, only to authorized repair workshops, or not be made available at all. Acquiring a critical spare part for a reasonable price, in an easy and quick way, contributes to a successful repair.

6 — Type of tools needed (EoD)

The number of tools needed to replace critical components, as well as their precise type and their availability, strongly influence the chance of initializing and successfully finishing the repair. We have divided the specific tools that can be needed for smartphone or tablet repair into classes corresponding to those defined in PrEN54445, from class A (Common Tools), class B (Product specific tools), class C (Commercially available tools) to class D (Proprietary tools).

7 — Accessibility for repair (EoD)

The accessibility of critical components, which fail most often, is a crucial factor for repair success. The accessibility of a component depends on the minimum number of steps to reach the component and the number of “difficult fasteners” needed to overcome to reach the component.

8 — Difficulty to repair (EoD)

The need for high force, difficult positioning of tools or additional activities adversely affect the accessibility of critical components. “Difficult fasteners” are connecting technologies which negatively influence the time-to-access the component and the overall repair experience and can be defined when the connecting technology 1) requires the use of specialized tools like secured screwdrivers, 2) is difficult to separate like glue or one-way screws, or 3) is difficult to reach like recessed or hidden screws.

9 — Health and safety risk (Q + EoD)

Any risk of injury leads to a lower chance of actually initializing and successfully finishing the repair. We evaluate three aspects influencing safety: 1) type of battery (risk of puncture), 2) need for the use of heat during the process and 3) use of high force for prying (increased risk of injuring the repairer).

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Basic Scoring Modules

SUSTAINABLY SMART

Criteria list based questionnaire

(Heuristic assessment)

Ease of Disassembly logging

(Work step protocol)

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IFIXIT EUROPE

1. Availability of Information

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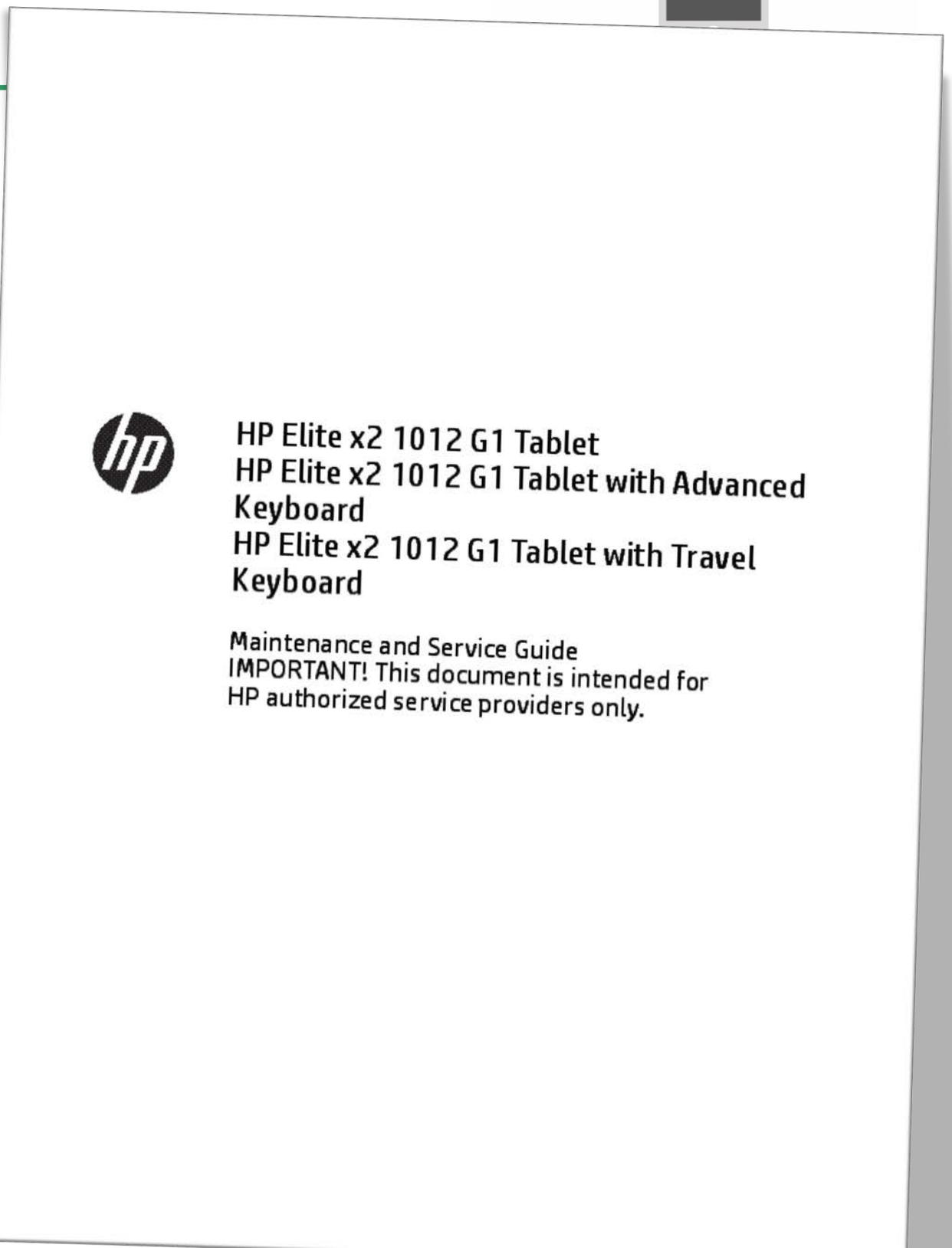

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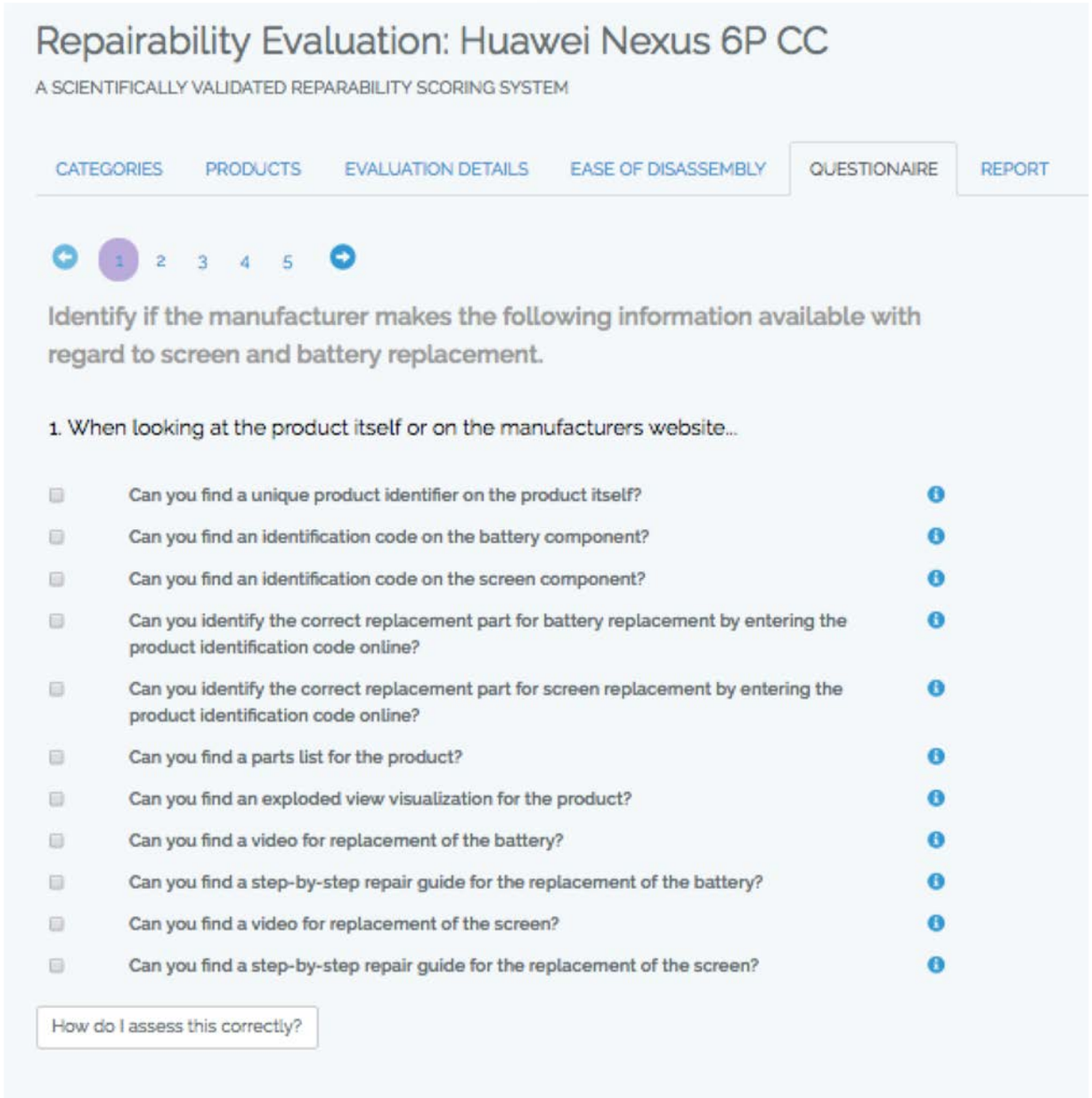
Scoring Criteria: Heuristic Assessment

SUSTAINABLY SMART

Module 1: Questionnaire

1. **Availability of information**
2. Deterrent messaging
4. Visual cues
5. Spare part availability
9. Health and safety risk

$$Cr_1 = Round\left(\frac{\sum_{i=1}^{n} w_i \cdot Ans_i}{\sum_{i=1}^{n} w_i} \cdot 10\right)$$



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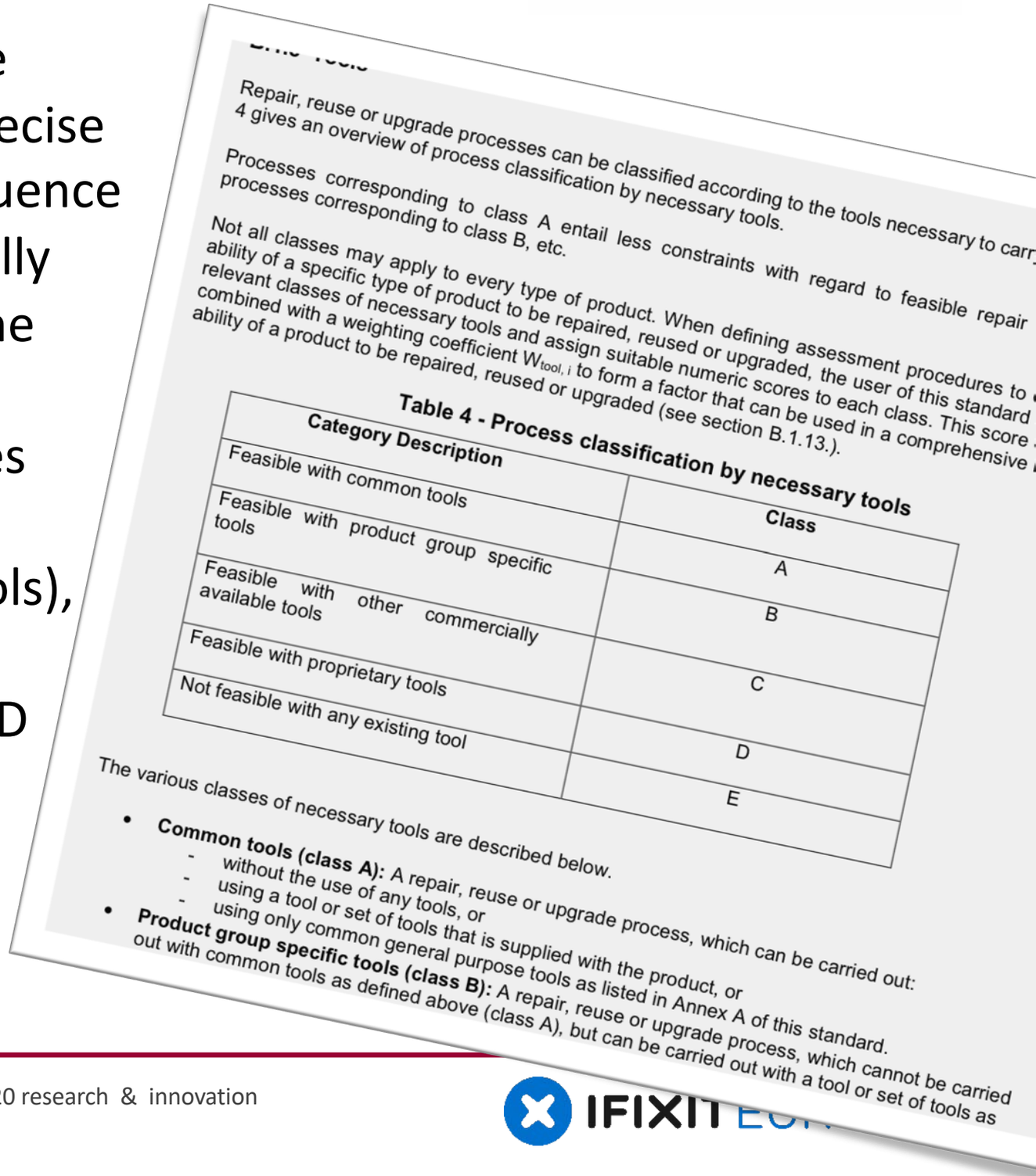
6. Type of Tools Needed

The number of tools needed to replace critical components, as well as their precise type and their availability, strongly influence the chance of initializing and successfully finishing the repair. We have divided the specific tools that can be needed for smartphone or tablet repair into classes corresponding to those defined in PrEN45554, from class A (Common Tools), class B (Product specific tools), class C (Commercially available tools) to class D (Proprietary tools).



Repair, reuse or upgrade processes can be classified according to the tools necessary to carr
4 gives an overview of process classification by necessary tools.

Processes corresponding to class A entail less constraints with regard to feasible repair processes corresponding to class B, etc.

Not all classes may apply to every type of product. When defining assessment procedures to ability of a specific type of product to be repaired, reused or upgraded, the user of this standard relevant classes of necessary tools and assign suitable numeric scores to each class. This score combined with a weighting coefficient $W_{tool,i}$ to form a factor that can be used in a comprehensive ability of a product to be repaired, reused or upgraded (see section B.1.13.).

Table 4 - Process classification by necessary tools

Category Description	Class
Feasible with common tools	A
Feasible with product group specific tools	B
Feasible with other commercially available tools	C
Feasible with proprietary tools	D
Not feasible with any existing tool	E

The various classes of necessary tools are described below.

- **Common tools (class A):** A repair, reuse or upgrade process, which can be carried out:
  - without the use of any tools, or
  - using a tool or set of tools that is supplied with the product, or
  - using only common general purpose tools as listed in Annex A of this standard.
- **Product group specific tools (class B):** A repair, reuse or upgrade process, which cannot be carried out with common tools as defined above (class A), but can be carried out with a tool or set of tools as

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Scoring Criteria: EoD Assessment

SUSTAIN ABLY SMART

Module 2: Ease of Disassembly Assessment

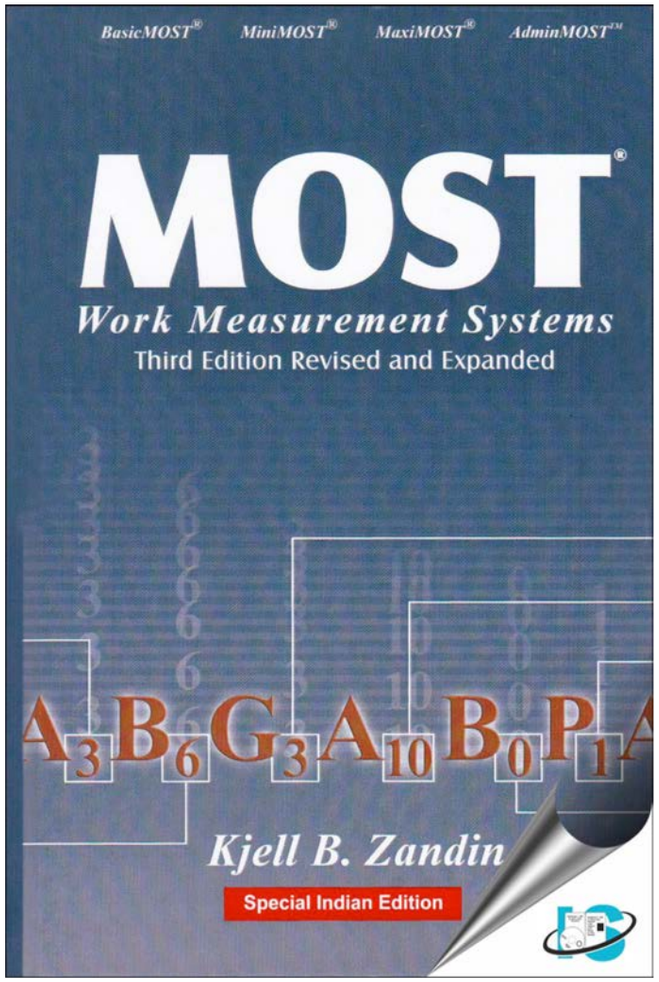
3. Path of entry
6. **Type of tools needed**
7. Accessibility for repair
8. Difficulty to repair
9. Health and safety risk

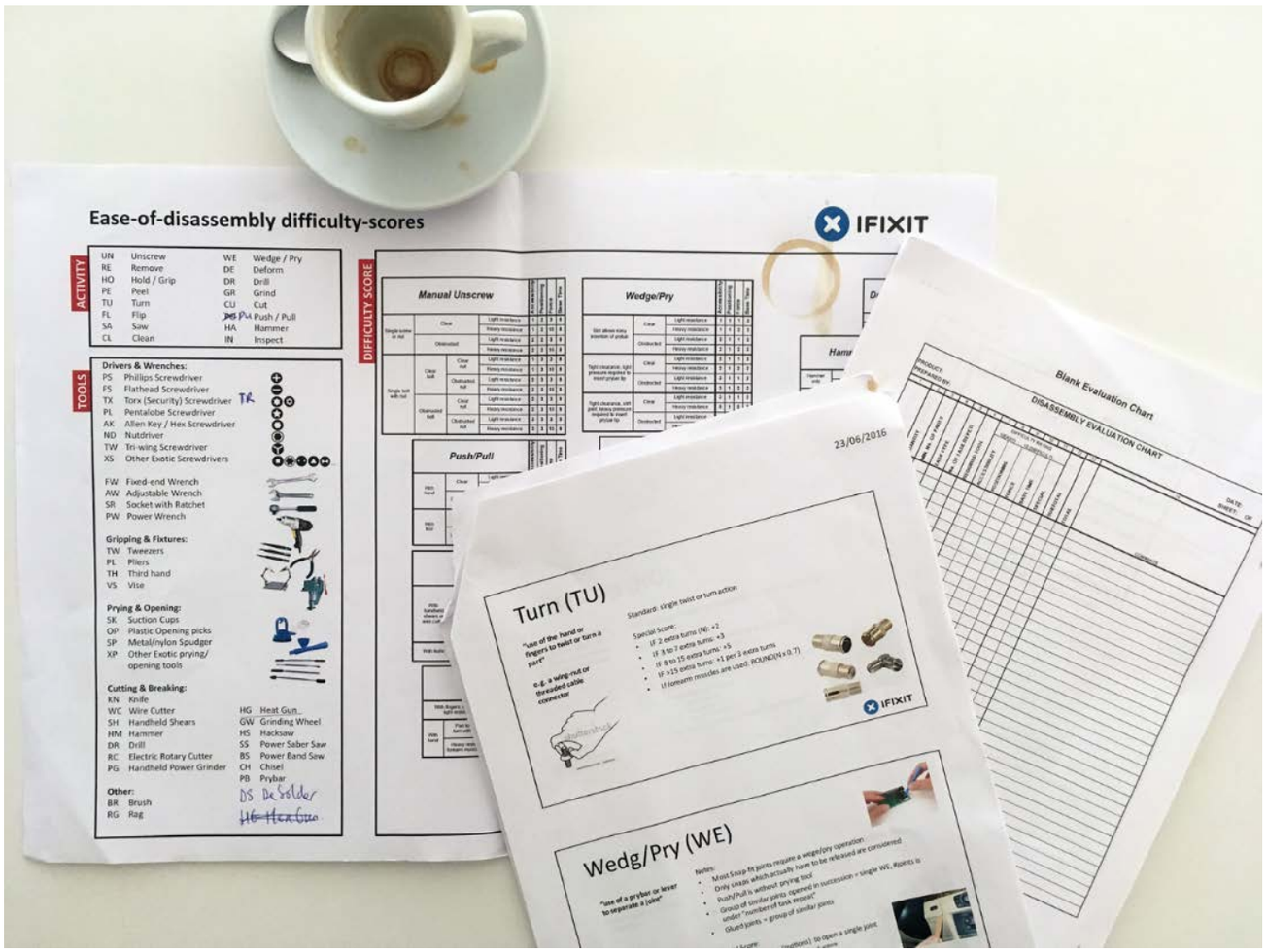
$$
\begin{aligned}
&Cr_6 \\
&\quad = 10 \\
&\quad - Count(Toolsize\{Underarm\}) \\
&\quad - 2 \cdot Count(Activity\{Deglue\}) \\
&\quad - Count(Toolsize\{ClassD\})
\end{aligned}
$$

Disassembly steps of Huawei Nexus 6P CC

Entry #	Component Name	Critical	Part of	Activity	#	Tool Used	Accessibility	Additionals
1	SIM card			Remove	1	Part	1;1;2;1	[]
2	top rear cover			Loosen Glue	1	Heatgun	3;1;1;2	[]
3	top rear cover			Loosen Glue	1	Lever Prybar	3;1;1;2	[]
4	top rear cover			Remove	1	Part	1;1;2;1	[]
5	bottom rear cover			Loosen Glue	1	Heatgun	3;1;1;2	[]
6	bottom rear cover			Loosen Glue	1	Lever Prybar	3;1;1;2	[]
7	bottom rear cover			Remove	1	Part	1;1;2;1	[]
8	rear cover			Unscrew	6	Philips Ph 00	1;2;10;8	[]
9	rear cover			Separate Snap Fit	1	Lever Prybar Guitar pick	2;1;2;2	[]
10	rear cover			Separate Snap Fit	4	Lever Prybar plastic opening picks	2;1;2;2	[21]
11	rear cover			Remove	1	Part	1;1;2;1	[]
12	connector plate			Unscrew	1	Philips Ph 000	1;2;10;8	[]

Disassembly Steps as a Proxy for Reparability





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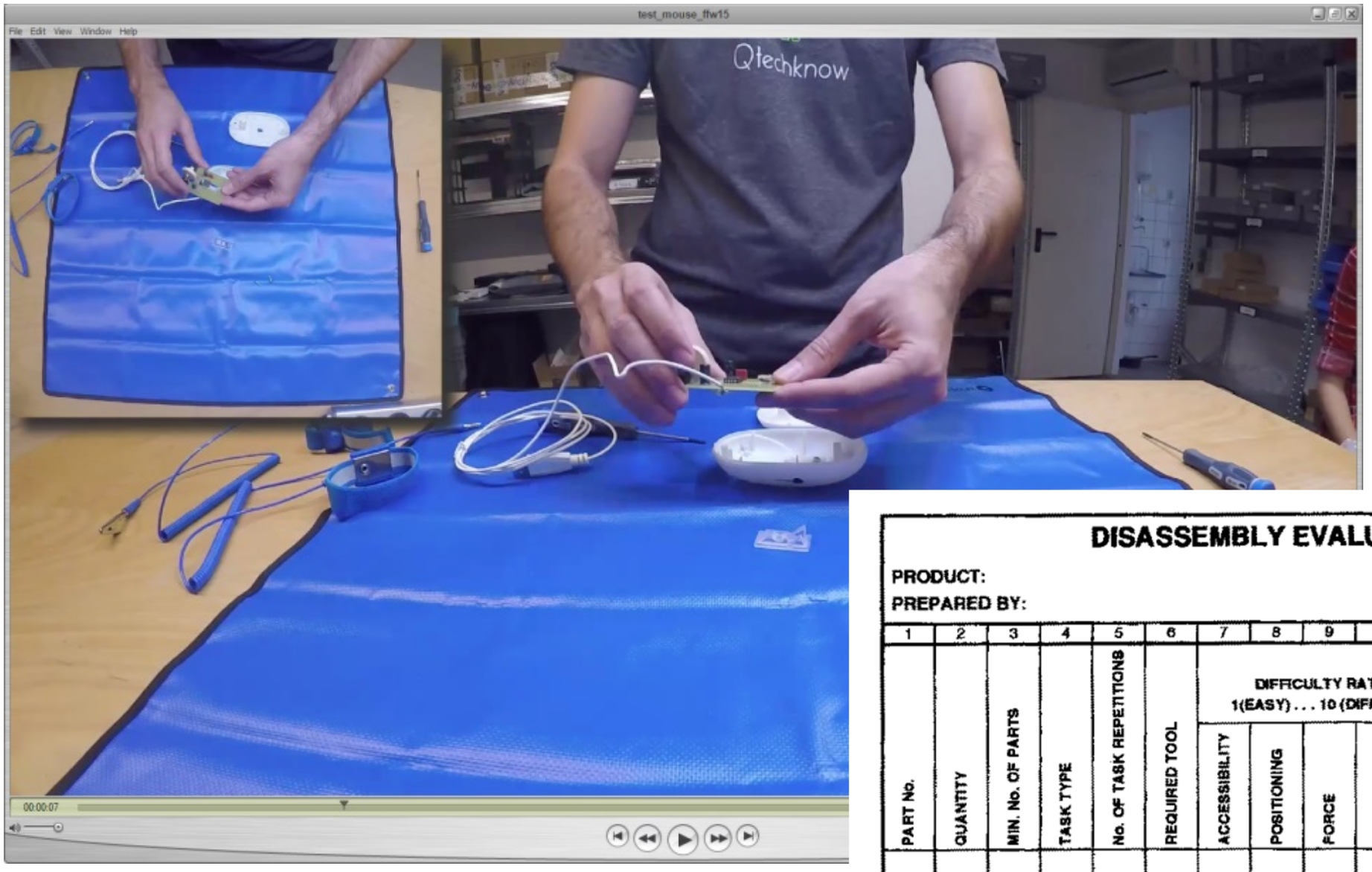
Ease of Disassembly (EoD)



DISASSEMBLY EVALUATION CHART

PRODUCT: DATE:

PREPARED BY: SHEET: OF

1	2	3	4	5	6	7	8	9	10	11	12	13	14
PART No.	QUANTITY	MIN. No. OF PARTS	TASK TYPE	No. OF TASK REPETITIONS	REQUIRED TOOL	DIFFICULTY RATING 1(EASY) . . . 10 (DIFFICULT)					SUBTOTAL	TOTAL	COMMENTS
						ACCESSIBILITY	POSITIONING	FORCE	BASE TIME	SPECIAL			

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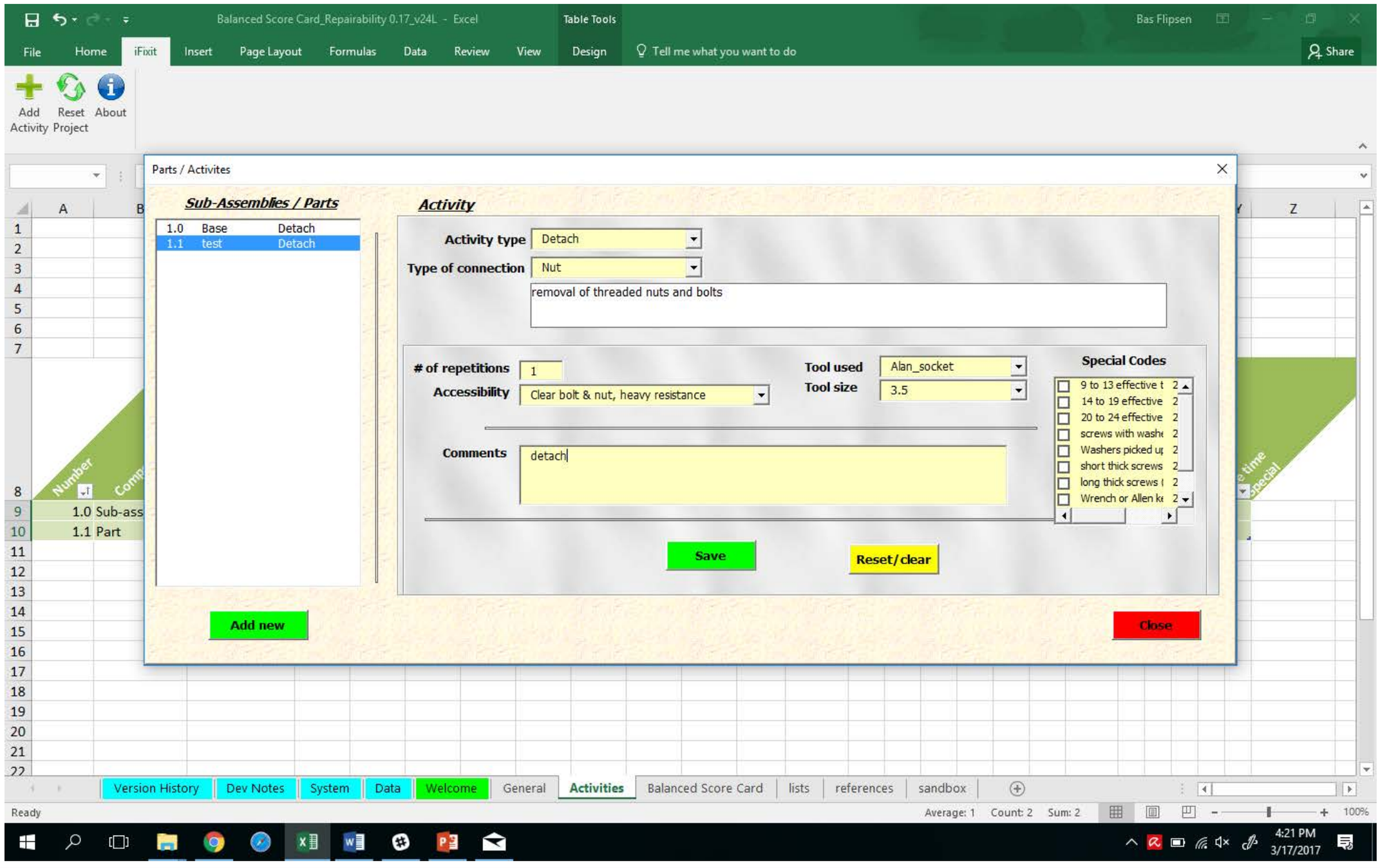
EoD Software Tool (Offline)

SUSTAINABLY SMART



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Finding a Balance

Questionnaire Module

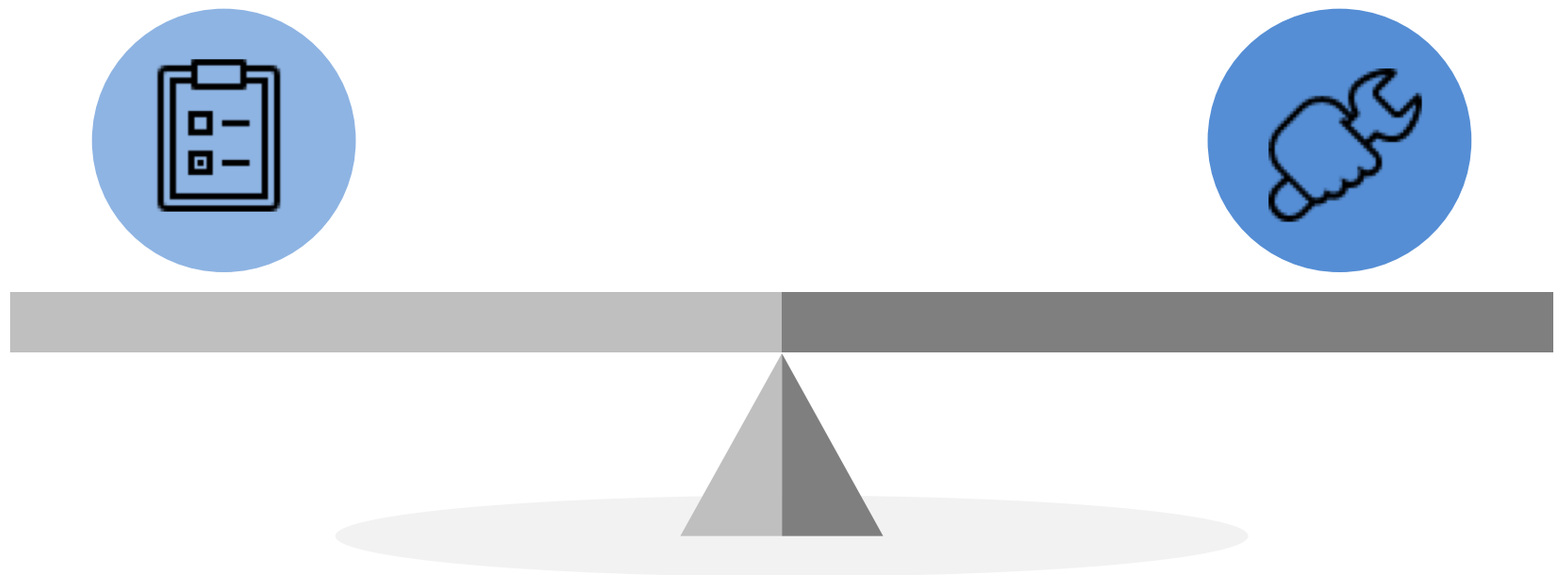
Easier to teach
Higher statistical variance

Qualitative Focus
Context-centered

EoD Assessment Module

Harder to teach
More exact & repeatable

Quantitative Focus
Product-centered



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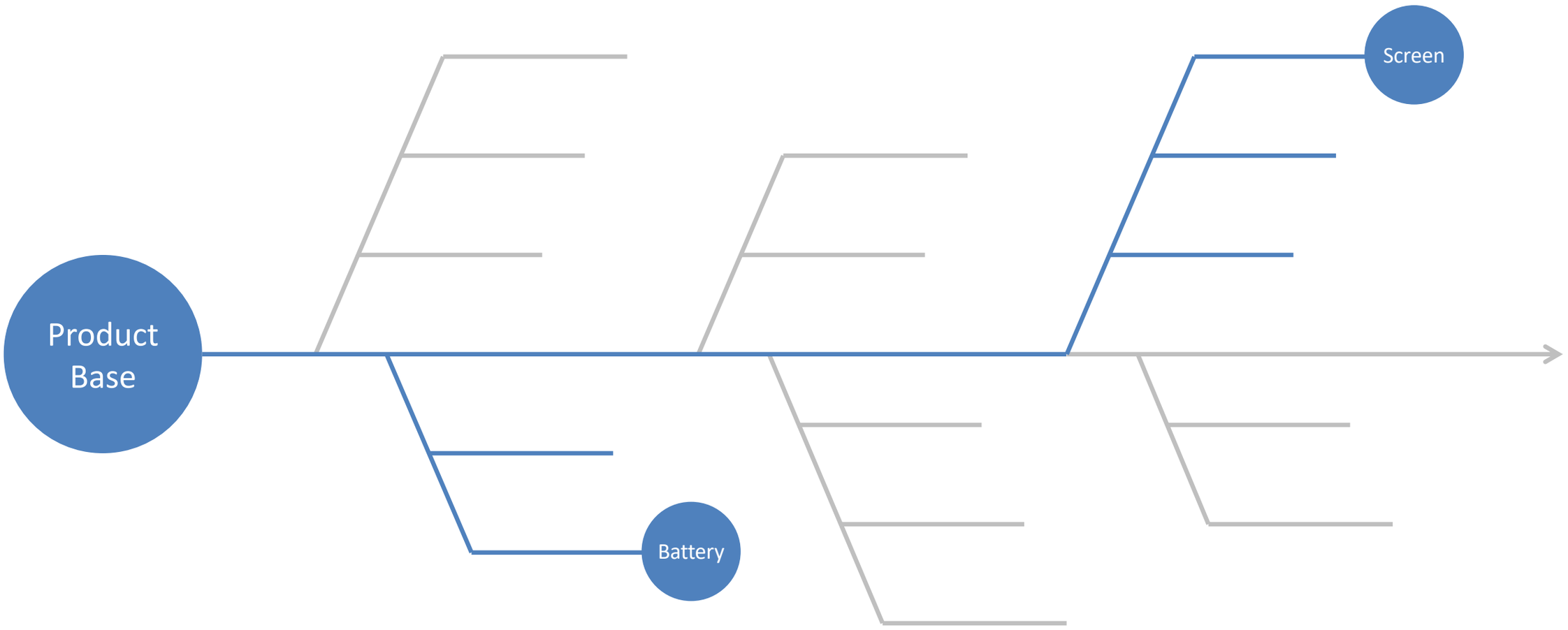
Identifiying Critical Components



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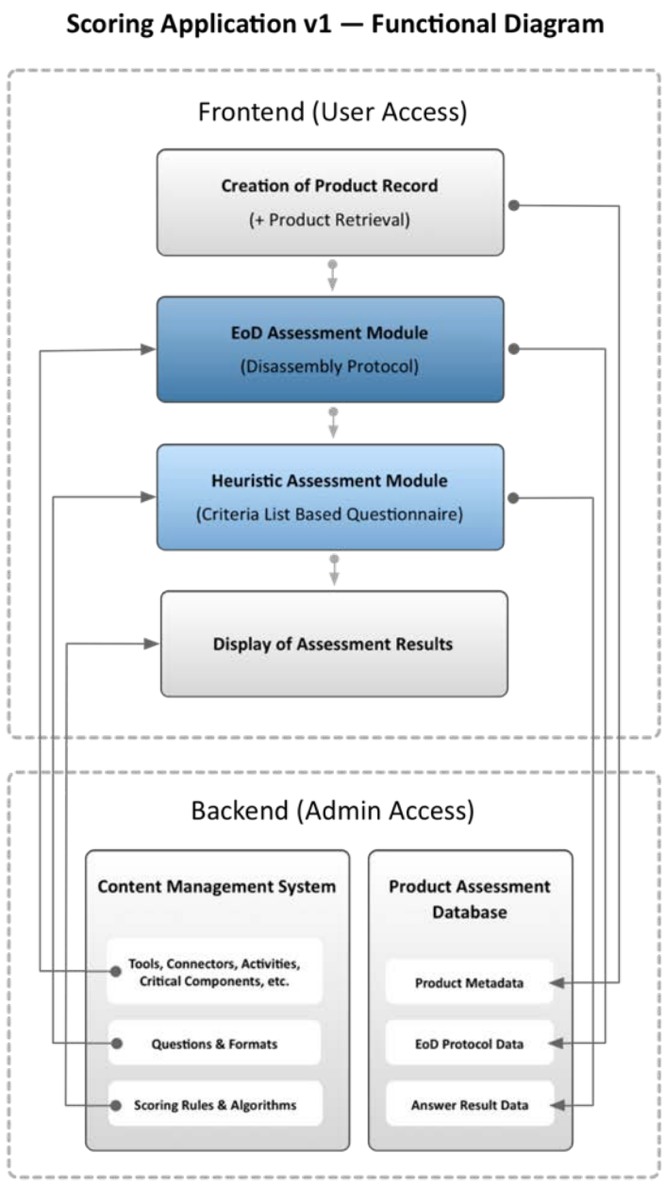
Online Scoring Software: Functional Overview



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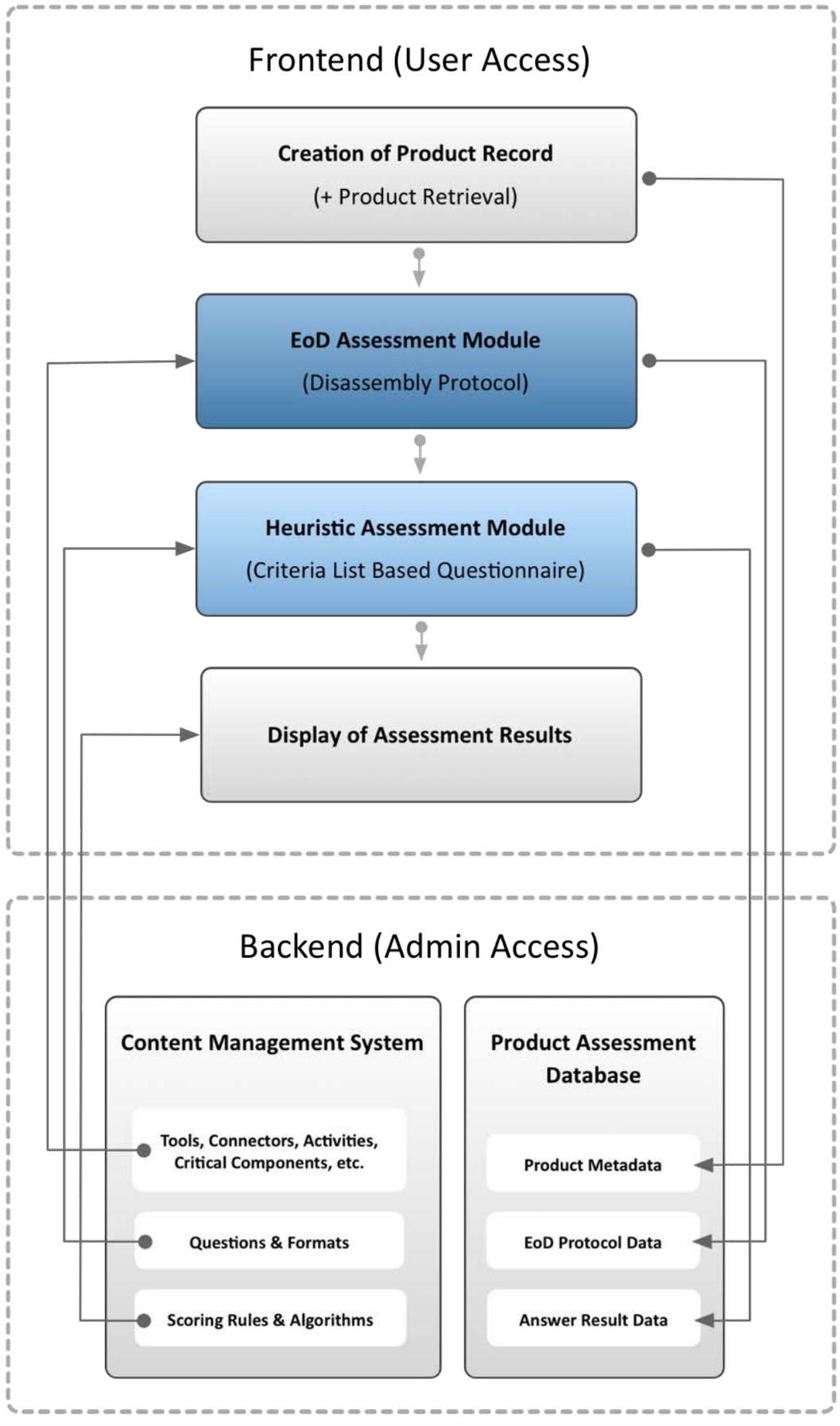
Scoring Application v1 — Functional Diagram



Outlook: Scoring of Smartphones/Tablets

- Benchmarking with outlier products
- Fine-tuning for improved grading
- Assessment series of market leading smartphones (iPhone, Samsung Galaxy S)

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Let’s Fix the Future