FREEDOM TO STUDY

i.e. the right to access sufficient information to understand how the piece of hardware—referred herein as the product—works and to retrace the underlying design rationale (as defined by Wang, Johnson, and Bracewell 2012).

Can be supported by the publication of schematics, 2D or 3D CAD files.

TRANSPARENCY
equals the freedom to study

It refers to the possibility for any interested person to access sufficient information to understand the product in detail without restriction.

Enables observation (and eventually feedback)

A product satisfies this criterion when CAD files are published.

T

FREEDOM TO MAKE

i.e. the right to use the product definition documents in order to make—in other words to produce, to manufacture—the piece of hardware.

Can be supported by the publication of bill of materials and assembly instructions.

REPLICABILITY
equals the freedom to make

It refers to the possibility for any interested person to physically produce the product.

Enables prototyping and production (and eventually co-production).

A product satisfies this criterion when assembly instructions and bill of materials are available.
***If you think it is irrelevant information, please specify how you satisfy this factor.**

R

FREEDOM TO MODIFY

i.e. the right to edit the product definition documents and to tweak or develop the product further for any purpose.

Can be supported by the publication of all documents in their original editable format.

ACCESSIBILITY
equals the freedom to modify

It refers to the possibility for any interested person to edit design information and therefore to further develop the product.

Enables further development (and eventually co-development)

A product satisfies this criterion when all published content is editable or when a guideline for participation is available.

A

FREEDOM TO DISTRIBUTE

i.e. the right to give or sell the product definition documents as well as the physical products fabricated with the help of these documents.

Is allowed by the publication of all documents under a licence which grants free redistribution including for commercial purposes.

COMMERCIAL USABILITY
equals the freedom to distribute

It refers to the possibility for any interested person to resell the product under licence.

Enables free trade

A product satisfies this criterion when licences applied to the non-electronic hardware allow commercial usage of the published content.

C

OS MODE 0

The disclosing of documentation developed in a private setting-defined as public innovation IS NOT an OPEN SOURCE development approach because IT NEITHER SUPPORTS:

- **Accessibility (A)**
- **Transparency (T)**

Once a new version of an open source product is released it becomes the basis for further continuous open source product development or public innovation within a private innovation process.

M0

OS MODE 1

In order to be labelled as "open source", this process requires at least:

- **Commercial Usability (C)**
- **Transparency (T)**
- **Accessibility (A)**

Accessibility is ensured by the use of editable formats (e.g. native and open CAD formats instead of STL files, native and open text editor files instead of PDF files).

M1

OS MODE 2

Whether a product is fully defined and can be produced it can be documented as an open source product.
In order to be labelled as "open source", this product can be delivered with additional information, which support production, such as:

- **Bill of Materials**
- **Assembly Instructions**

Production and marketing require that this content be published under licenses that permit commercial use.

M2

OS MODE 3

We need to consider the existence of:

- **CURRENT STATUS (i.e., the level of openness actually achieved)**
- **PROJECT STATUS (i.e., the level of potential openness of the project)**

During development, it is advisable to keep track of both "STATES" so as to facilitate the achievement of "openness" that best suits the project.

M3

GOAL 1

WE TRY to use the methods defined in this article to allow a SIMILAR ANALYSIS to various OSH PRODUCTS, from purely mechanical to mechatronic.

WE WANT a DEFAULT OPENNESS FORM that HELPS RESEARCHERS have an easily available and analyzable set of data.

G1

GOAL 2

WE TRY to rework the theoretical principles to facilitate the OPEN DESIGN PROCESS.

WE WANT a TOOLKIT that leads to the definition of actually usable and useful documentation that HELPS DESIGNERS understand the level of openness of the project even in the development phase.

G2

CC LICENCES

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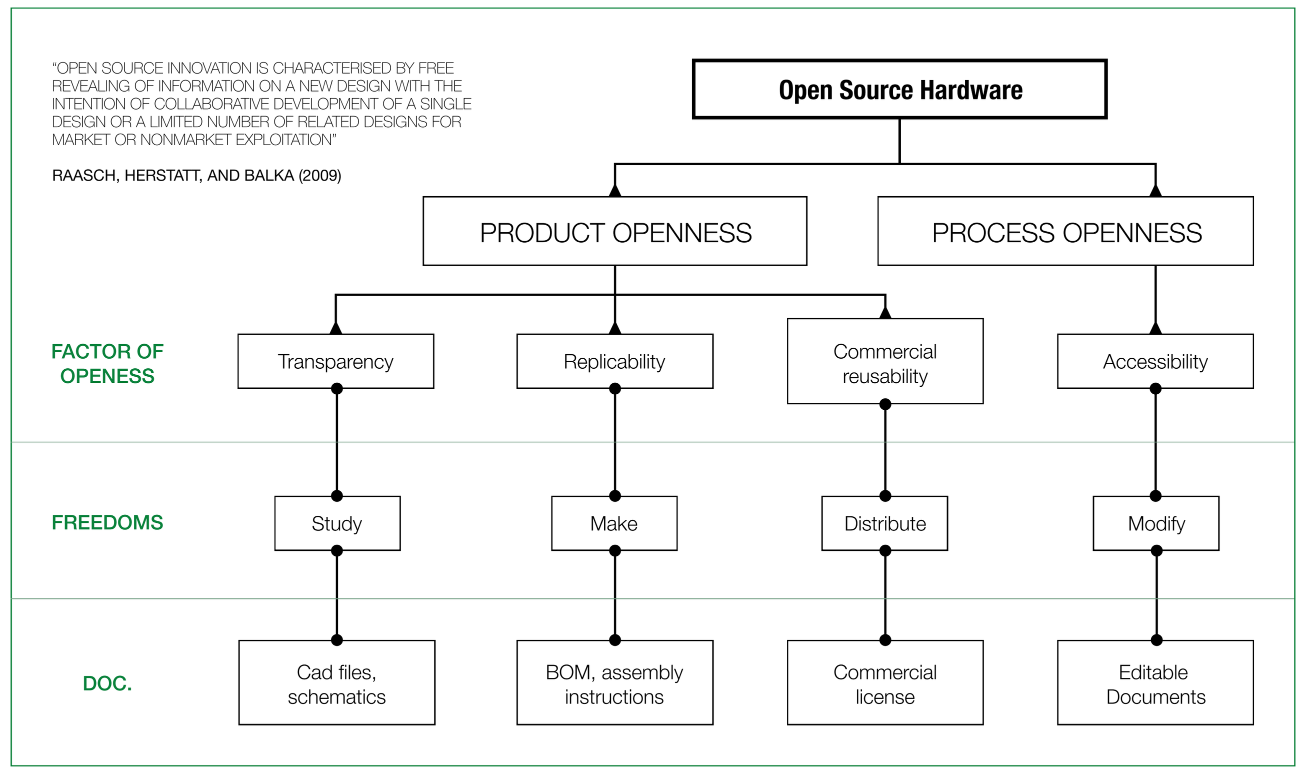
- **CC0** (aka CC Zero) is a public dedication tool, which allows creators to give up their copyright and put their works into the worldwide public domain. CC0 allows reusers to distribute, remix, adapt, and build upon the material in any medium or format, with no conditions.

****CC Plus** Since CC licenses are not exclusive, it is always possible to add agreements which – without reducing the rights conferred by the license – offer, under certain conditions, additional possibilities to all or some licensees. This is the model followed, for example, in the context of the CC Plus "protocol".

"OPEN SOURCE INNOVATION IS CHARACTERISED BY FREE REVEALING OF INFORMATION ON A NEW DESIGN WITH THE INTENTION OF COLLABORATIVE DEVELOPMENT OF A SINGLE DESIGN OR A LIMITED NUMBER OF RELATED DESIGNS FOR MARKET OR NONMARKET EXPLOITATION"

RAASCH, HERSTATT, AND BALKA (2009)



Open Source Hardware Lifecycle

*The lifecycle model would omit a large part of the actual practices rightly claiming the label of "open source hardware", which also includes the free revealing of innovations achieved in private settings.

Mode 3 · Mode 1: release · Mode 2: reveal · redesign · redesign

	Open Source Product Development	Project Status Open Source Product	Public Innovation (not OS)
PRODUCT LIFECYCLE PHASE	Product development process	Production, Commercialization, Use, End of Life	Product development process
OBJECTIVE OF OPEN SOURCE PUBLICATION	Support community-based product development	Support product diffusion, Updatability and Reparability	
CONTENT OF THE PUBLISHED INFORMATION	Early phases: Text, Shematics Late phases: CAD files	CAD files, Assembly Instructions, Bill of Materials	
PROPERTIES OF THE PUBLISHED INFORMATION	Editable, Commercially usable	Commercially usable	

HOW OPEN ARE YOU?

M1 · M2 · M3 CS · M3 PS

- a CAD files available → T
- b CAD files editable → A
- c Assembly instructions available → d Assembly instructions editable (R)
- e Bill of materials available → f Bill of materials editable
- g Guidelines for participation
- cc Assembly instructions irrelevant*
- ee Bill of materials irrelevant*
- R* *please specify how you satisfy R factor
- h Commercial usage allowed — C
- i Licence: ☐ CC-BY ☐ CC-BY-SA ☐ CC-BY-NC ☐ CC-BY-NC-SA ☐ CC-BY-ND ☐ CC-BY-NC-ND ☐ CC0 ☐ CC Plus
- j Contains electronics: ☐ NO (Mechanical Product) ☐ Mechanical Process ☐ Electric Process ☐ Electronic Process ☐ YES (Mechatronic Product)
- k Maturity: ☐ 1. Design ☐ 2. Prototype ☐ 3. Production/DIY ☐ 4. Production/Kit ☐ 5. Production/full product
- l Status of the community: ☐ Active ☐ Inactive
- m Product category: ☐ Machine-tools ☐ Vehicles ☐ Robotics ☐ Agricultures ☐ Medical Equipment ☐ Musical Equipment ☐ Laboratory Equipment ☐ Toys and games ☐ Power Supply ☐ Furnitures ☐ Others

*If in doubt, ask CIC

THE SOURCE OF OPEN DESIGN

YOU CAN'T select one of the criteria b c d e f g ...... the dotted line BELOW

BEFORE having selected at least one ...... ABOVE

T ABOVE ALL!
In the event that T is not achieved in the absence of consultable CAD files, the reasons can be traced with the introduction of contextual criteria.

For the A criterion, if one of a, c, e is selected it is obligated to select → the corresponding editable criteria b, d, f (equation 1), otherwise ○○○○○○ **THE ONLY POSSIBLE CHOICE** is to select g and provide details with cc e/o ee aimed at also defining the satisfaction of R.

R* indicates that another way to satisfy R is specified.

C must necessarily be true for the "openness" concept itself.

PART I – CRITERIA REGARDING SHARED PRODUCT-RELATED DOCUMENTATION

a	CAD files available	*referring to non-electronic hardware
b	CAD files editable	*CAD files are considered editable if they are released in their original format. They are not considered editable if they are only released in an export format such as PDF or STL which does not allow further modifications
c	Assembly instructions available	*referring to non-electronic hardware
d	Assembly instructions editable	*assembly instructions are considered editable if they can be edited in a web 2.0 environment or downloaded as editable files. A file is furthermore considered editable if it is released in its original format. It is not considered as editable if it is only available in an export format such as PDF
e	Bill of materials available	*referring to non-electronic hardware
f	Bill of materials editable	*a bill of materials is considered editable if it can be edited in a web. 2.0 environment or downloaded as an editable file. A file is furthermore considered editable if it is released in the original format. It is not considered editable if it is only available in an export format such as PDF
g	Guidelines for participation	*i.e. whether guidelines for participation or a dedicated call for contribution are provided to potential contributors
h	Commercial usage allowed	*i.e. whether the licence applied to the non-electronic hardware allows commercial usage of the published content. If no licence is applied, the criterion is set to false

(T), (A), (R), (C) IN A BOOLEAN LOGIC SYSTEM

$$\begin{cases} T = a \\ A = [(a \lor c \lor e) \land (a \rightarrow b) \land (c \rightarrow d) \land (e \rightarrow f)] \lor g \\ R = c \land e \\ C = h \end{cases}$$

EQ.1

PART II – CRITERIA REGARDING CONTEXTUAL INFORMATION

i	Licence	*referring to non-electronic hardware
j	Contains electronics	*i.e. whether the product contains electronic hardware components as well
k	Maturity	*defines the maximum maturity level achieved by one of the eventual versions of the product over time. Five maturity levels are defined in the order of increasing liability risk: 1. **Design.** There is only a theoretical design that is still to be fully developed. No liability of the product originator applies. 2. **Prototype.** The early design phases have been completed and the first functional prototype has been built. No liability of the product originator applies. 3. **Production/DIY.** The product is fully defined and documented and can be replicated. No liability of the product originator applies. 4. **Production/Kit.** The product is sold by a commercial actor as a kit. Limited availability applies to the vendor. 5. **Production/full product.** The product is sold by a company as a finished product. Full availability applies to the vendor.
l	Status of the community	*i.e. whether the community is active. The community is considered inactive in case no activity (encompassing either product development or sales and marketing) can be detected on the website or the collaboration platforms within one year
m	Product category	Classification of the products in product groups

NB: For the four criteria a, c, e, g the following rule is applied:
It is considered **unavailable** if the necessary information to satisfy a criterion cannot be found in less than **10 minutes**. Accessibility to documents required by the Open Source Definition implies not only that these documents can be accessed, but also that they can be found easily.

OI
GAMMA FUNCTION

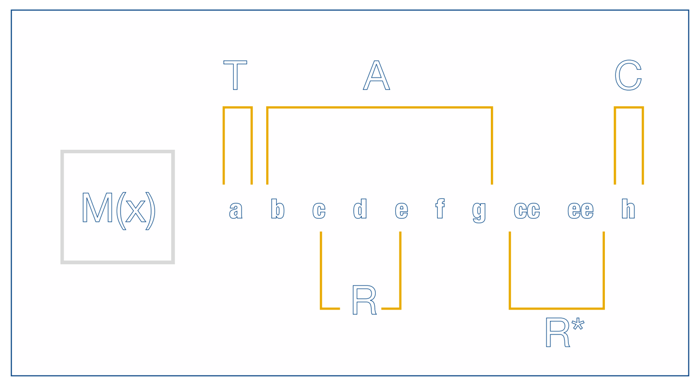
$0 \leq OI \leq 8$

$$OI = \Gamma(a) + \Gamma(b) + \Gamma(c) + \Gamma(d) + \Gamma(e) + \Gamma(f) + \Gamma(g) + \Gamma(h)$$

$$\text{where} \quad \Gamma(x) = \begin{cases} 1 & \text{if } x \\ 0 & \text{if } \neg x \end{cases}$$

EQ.2

M1 · M2 · M3 CS · M3 PS



M_	a	b	c	d	e	f	g	cc	ee	h	

OPENNESS

C1	T A R C	Fully open products which satisfy almost all openness criteria and having hence a high average OI value
C2	T A R* C	Products being transparent, replicable and commercially usable, but not accessible because their replicability is not given by the assembly instructions and the bill of materials. Contextual criteria should be consulted.
C3	T A R C	Products being transparent, replicable and commercially usable but not accessible. Their average OI value is medium to high and is mainly handicapped by the lack of accessibility.
C4	T A R C	Products being transparent, accessible and commercially usable but not replicable. Their average OI value is medium to low and is mainly handicapped by the lack of replicability.

CLOSURE

C5	T A R C	Products for which almost no documentation can be found and out of which two thirds do not provide commercially usable documentation. Their average OI value is very low.

WHAT IS THE SOURCE OF OPEN SOURCE HARDWARE?

CONDITIONS OF EXISTENCE

1. **"All parts, designs, code, and rights under the control of the creator must be made open"** (Open Source Hardware Association 2017)
2. **Avoid starting to claim a product is open source before the corresponding documentation is put online**
3. **Keep the community active and the data online (avoid "dead links")**

C.E: