THE SOURCE OF OPEN DESIGN

a reworking of

Bonvoisin, J., Mies, R., Boujut, J.-F. and Stark, R., 2017. What is the "Source" of Open Source Hardware?. Journal of Open Hardware, 1(1), p.5 (Published on 05 Sep 2017)

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by

CIC

FOR

HOW

TO

HACK

THE

DESIGNING COMMUNITY AND SHARED VALUES

EVERYBODY WANT TO BE A CIC

Who is CIC?
CIC = Contributor in Community

That is, active participant who contributes as he can, according to his skills by making himself available to help others and who exchanges his knowledge to improve the world around him.
Developing a civic identity, it is open, respectful, inclusive and I would add transparent and accessible (read to understand).
The community shares values that for the principles of self-determination and self-regulation are never absolute but are subject to debate.

The need for a common language and guidelines, however, lead us to define two indisputable values, namely the concepts of **Ecological Sustainability** and **Human Dignity**. From these values can arise a sense of **Glocal Belonging** from which to rebuild many small communities, cultures and subcultures, which coexist ecologically with each other and co-evolve with the environment.

There is a “fil rouge” that ties everything together.
Everything is evolving on the network!

POTENTIAL OF THE RESEARCH

The dataset on which the article is based upon has been published with a CC-BY licence (Bonvoisin and Schmidt 2017b, http://doi.org/10.14279/depositonce-5977).

An actualized version of the dataset is available under the same licensing terms in the Open Source Hardware Directory.

This database of complex OSH products allows any interested person to add references of OSH products, or to edit existing ones.

The content of this database can be used for any purpose, such as future research as suggested in this article.

The objective of the methodology pursued in the article and in the generation of the data was to generate an overview of the field of OSH.

The authors cannot guarantee that the presented data of more than 2000 items is free of errors.

Should the originators or contributors to the OSH products referenced in the dataset consider their products misrepresented, the authors kindly invite them to make corrections. They are free to edit the provided database or inform the authors of detected errors.

1861 VIEWS

436 +1 DOWNLOADS

19 CITATIONS

21 TWITTER

DESPITE THE SCOPE OF THE RESEARCH IT DOES NOT SEEM TO HAVE HAD MUCH PUBLICITY

WHAT HAVE WE **LEARNT**

WHAT HAVE WE **DEDUCED**

WHAT WE HAVE **DONE**

OR AT LEAST WE **TRIED**

While the transfer of open source principles from software to hardware historically and logically started with electronic hardware (Gibb 2014), other technologies are increasingly impacted by the phenomenon.

The extension of open source practices to non-electronic hardware such as mechanical products is of particular interest in terms of documentation.

Electronic hardware is a very standardized field where components are purchased off the shelf. But this is not the case for mechanical hardware where non-standardized free form components play a large role.

Also, particularly interesting is the consideration of complex products. **Product complexity is** defined by Jacobs (2007) as **“a design state resulting from the multiplicity of, and relatedness among, product architectural elements”**.

This characteristic influences the level of professionalization required in the development and production of a given product. It also determines whether production can take place in either DIY or industrial production settings. Noteworthy is that, **while DIY and OSH are two interwoven phenomena, not every OSH product is meant to be produced in a DIY production setting** (Bonvoisin, Galla, and Prendeville 2017).

Product complexity also relates to design effort in terms of resources consumed and process duration (Rodriguez-Toro, Jared, and Swift 2004). **Highly complex products tend to require inputs from multiple people and are more relevant for the topic of collaborative design.**

THE FOUR FREEDOMS OF THE OPEN SOURCE

The Open Source Hardware Statement of Principles 1.0 states that:

“Open source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design” (Open Source Hardware Association 2016).

It is based on the assumption that publishing a “design” (alternatively termed “documentation”) realizes the four freedoms of the open source concept which are reinterpreted in the context of tangible products as the freedom to study, modify, make and distribute.

A closer look at the definitions of widely recognized OSH licences and current practices of OSH seeks to give some hints and shows that **the four freedoms of open source tend to be supported by different document types or properties** (Bonvoisin and Schmidt 2017a).

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.

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.

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.

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.

THE THREE FACTORS OF OPENNESS

Scholarly definitions—mostly stemming from innovation management research—deliver categories which are consistent with the Open Source Hardware Statement of Principles 1.0 without, however, giving further details on the nature of the documentation to be published.

Freedoms to study, to edit and to make are consistent with the three factors of openness defined by Balka, Raasch, and Herstatt (2014).

The four freedoms and corresponding factors of openness cover both **"distinct and competing meanings" of openness** identified by von Hippel (2010) :

- The permeability of the innovation process to the participation of external people
- The public sharing of documentation

Transparency, replicability and commercial usability are about sharing documentation publicly. Accessibility is about enabling the participation of external people in the design process.

Note:

While Transparency is about sharing files which are required for the development process of the product and exist whether or not the product is open source, Replicability requires the formalization of assembly instructions and bill of materials, which is a time intensive activity.

Moreover, assembly instructions may only be relevant for products which are meant to be produced in a DIY production setting. In the context of projects dedicated to the development of complex OSH products which are meant for industrial production, assembly instructions may be secondary or even irrelevant information.

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

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

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

MISSING

*If in doubt, ask CIC

THE FOURTH FACTOR OF OPENESS

What is missing in this contribution is the fourth factor of openness termed henceforth commercial usability, which addresses the above listed “freedom to distribute”.

Commercial usability is related to Intellectual Property (IP) risks. **The commercial usability aspect is at the core of the concept of open source**, still, more than one third of the products are not provided with a licence allowing commercial usage or are published under licences excluding commercial usage.
In the latter case, these products are actually unambiguously not complying with the Open Source Hardware Statement of Principles 1.0 which **requires explicitly the use of licences allowing commercial usability.**

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

CREATIVE COMMONS LICENCES

We believe that **knowing the type of licenses will make it easier to understand what openness facets** (we recommend to consult the **link** Creative Commons directly).

CC is an international nonprofit organization that sustains the thriving commons of shared knowledge and culture we need to address the world's most pressing challenges and create a brighter future for all.

Together with their global community and multiple partners, they build capacity and infrastructure, they develop practical solutions and they advocate for better sharing – sharing that is contextual, inclusive, just, equitable, mutual and sustainable.

Creative Commons licenses give everyone from individual creators to large institutions a standardized way to grant the public permission to use their creative work under copyright law. From the reuser's perspective, the presence of a Creative Commons license on a copyrighted work answers the question, "What can I do with this work?"

Creative Commons licenses are available in three forms:

- The Commons Deed (i.e. the user friendly symbols summarizing the license terms)
- The Legal Code (the actual full license agreement)
- The CC REL – Creative Commons Rights Expression Language (the set of machine-readable information).

There are six different license types, listed to the right from most to least permissive here.

CC may includes the following elements:

- **BY** – Credit must be given to the creator
- **SA** – Adaptations must be shared under the same terms
- **NC** – Only noncommercial uses of the work are permitted

***in this case it is understood that the product can be distributed but without profit**

- **ND** – No derivatives or adaptations of the work are permitted

***may not satisfy A, but for some products it might be better that way**

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Fonte:

https://creativecommons.org

https://creativecommons.it/chapterIT/

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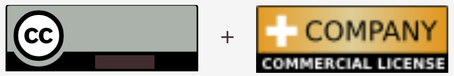

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LINK: Creative Commons

THE MEANING OF OPENNESS

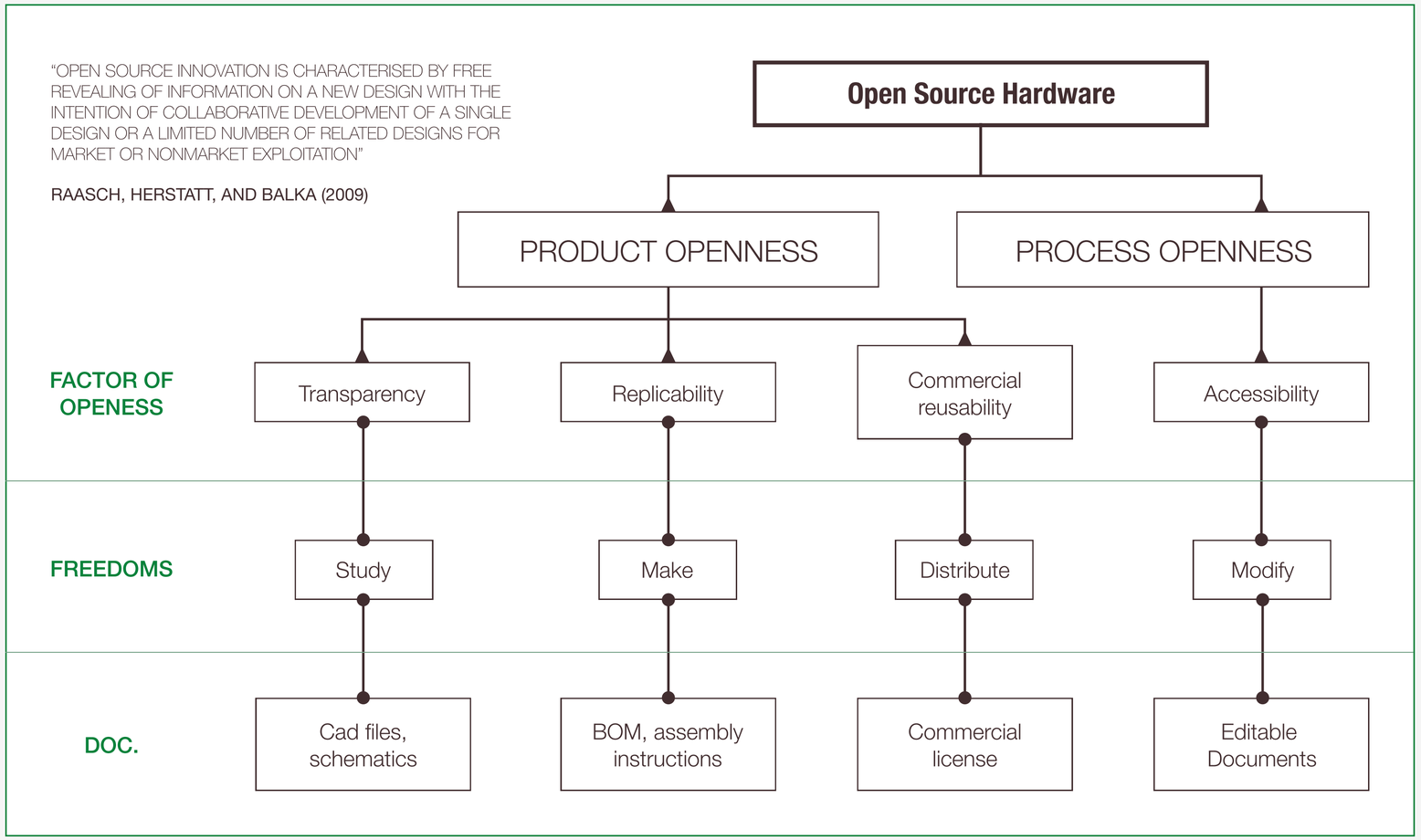
Aitamurto, Holland, and Hussain (2015) term two meanings of openness:

- **process openness** (whether the innovation process is open or closed)
- **product openness** (whether the innovation outcome is open or closed).

Huizingh (2011) defines **open source innovation as a result of both process and product openness.**

"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)



Note:

The Open Source Hardware Association's Open Source Hardware Certification Program states that "all parts, designs, code, and rights under the control of the creator must be made open" (Open Source Hardware Association 2017).

LINK: http://doi.org/10.5334/joh.7

OPEN SOURCE HARDWARE PRODUCT CHARACTERIZATION CRITERIA

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

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.

LINK: http://doi.org/10.5334/joh.7

OPENNESS ASSESSMENT CRITERIA

T.A.R.C.

The four criteria of Trasparency **(T)**, Accessibility **(A)**, Replicability **(R)** and Commercial Usability **(C)** are defined as logical operations on the Boolean values [a,…,h] as depicted by **equation 1:**

Note:

A boolean variable (or boolean) is a data type that takes on only two possible values. Typically the two possible values are indicated as "true" or "false" or as 1 or 0.

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

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

EQ.1

In addition to this, a **global openness index (OI)** is defined as a cumulative point system. A product gets one point each time one of the criteria a, b, c, d, e, f, g, and h is satisfied.
The openness index is defined in **equation 2:**

Note:

An openness index equal to 8 means the product fully satisfies the best practices of OSH. An openness index equal to 0 means the product satisfies none of the criteria defining OSH.

Fonte:

The function is a gamma function, or Euler gamma function, which appears in many formulas of mathematical analysis, physics and mathematical statistics.

https://core.ac.uk/download/pdf/31030433.pdf

OI
GAMMA FUNCTION

$$0 \leqslant OI \leqslant 8$$

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

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

EQ.2

LINK: http://doi.org/10.5334/joh.7

IDENTIFICATION OF CLUSTERS BASED ON THE OPENNESS INDEX (OI)

In order to identify possible typical profiles, the **k-medioids algorithm** (pag. 29) was applied, leading to the **identification of 5 clusters.**

The results of the research tend to highlight the existence of **two OSH project archetypes:**

- MODE 1 = use of open source publication of product-related documentation as a means **to support community-based product development**
- MODE 2 = use of open source publication of product-related documentation as a means **to support diffusion of their privately developed product**

NB: The Open Source Hardware Statement of Principles 1.0 requires explicitly the use of licences allowing commercial usability.

Note:

Cluster C1 can be interpreted as a combination of these two archetypes, i.e. as projects of C4 which achieved the product development phase, reached the production and commercialisation phase and started to strive for replicability.

LINK: http://doi.org/10.5334/joh.7

*If in doubt, ask CIC

THE ROLE OF CONTEXTUAL CRITERIA

In order to **identify typical patterns in the publication of product-related documentation**, products are clustered according to the values of the eight binary criteria [a,…,h] defined above.

If you are interested in more information regarding this method, it is advisable to consult the direct source.

We try to simplify the display of contextual information criteria based on the collected data.

On page 6, we introduced an overview of the licenses we are aware of (i.e. CC licenses).

Licence

- ☐ CC-BY
- ☐ CC-BY-NC
- ☐ CC-BY-ND
- ☐ CC0
- ☐ CC-BY-SA
- ☐ CC-BY-NC-SA
- ☐ CC-BY-NC-ND
- ☐ CC Plus

Knowing the type of license could help in terms of research and development of the project itself

THE ROLE OF CONTEXTUAL CRITERIA

In the research only the openness of mechanical components has been assessed and those of software and electronic hardware components contained in mechatronic products have been left aside.

It is therefore possible that a mechatronic product appears here as non-open although the corresponding electronic hardware and software are open source.

Following this explanation, there would be a high chance that the average openness of mechanical parts of mechatronic products should be lower than those of purely mechanical products.

* **This explanation is however not supported by the gathered data**, as the average openness index is higher for mechatronic products than for purely mechanical products.

Let us better define the concepts of mechanical product and mechatronic product:

"*Mechatronics are those systems that have a synergistic integration of mechanical engineering, electronics and intelligent control systems.*"
(Fukada and Harashima, 1996)

From the study we include to the explanation one element, namely the **electro-mechanical product**, such as a lamp may be.

What is the difference between mechatronic and electro-mechanical devices?

The latter involve an electrical signal to create a mechanical movement, or conversely a mechanical movement to create an electrical signal
In mechatronics, on the other hand, it is electronics.

What is the difference between electrical and electronic devices?

- An **electrical** device changes current into another form of energy (lamp, induction plate, hair dryer, etc.)
- An **electronic** device controls the movement of electrons to perform an operation (TV, radio, smartphone, etc.)

AN ELECTRO-MECHANICAL PRODUCT STILL FALLS INTO THE CATEGORY OF A MECHANICAL PRODUCT.

This could also depend on a factor of skills needed to use the product, which in the mechanical product tends to be medium to low while in the mechatronic product is much more variable.

*on the following page

THE ROLE OF CONTEXTUAL CRITERIA

j + considerations

This could be because there is a research error in considering only the product without differentiating it from the development process.

In the case where the project is being developed according to MODE 1, I would not be able to define this criterion because I could design a mechanical product (e.g.lamp) with the help of electronic (Arduino, 3D Printing, etc.) and/or electrical processes.

That is why we find it interesting to also consider Mechanical Processes, Electrical Processes and Electronic Processes.

j Contains electronics

- ☐ NO (Mechanical Product)
- ☐ YES (Mechatronic Product)

j Contains electronics

- ☐ NO (Mechanical Product)
- ☐ YES (Mechatronic Product)
- ☐ Mechanical Process
- ☐ Electric Process
- ☐ Electronic Process

*** This explanation is however not supported by the gathered data**

While we cannot identify in the "made and finished" Open Source Product the skills needed for use (which will depend on Design), we can assume (for now) a maximum of 3 levels of complexity during product development (which will depend on Design and the skills of the Actors).

THE ROLE OF CONTEXTUAL CRITERIA

The research compares the openness of all products categorized along three assessed contextual criteria: **product maturity**, whether **products are purely mechanical or mechatronic**, and whether **the surrounding community is active or inactive.**

A first possible reason for the absence of published **documentation may** be that such documentation **does not exist and cannot exist** in the level of detail required by the criterion used by the research.

Indeed, in the early stages of design, the product documentation is not mature enough to formalize the product concept in CAD files, assembly instructions and bills of materials.

This explanation tends to be supported by the data collected, as the average open rate of products in the early stages (concept and prototype) is significantly lower than that of the production stages (DIY, kit, full product production).

The percentage of products that meet the transparency criterion grows together with the maturity of the product.

It is less than 54% in the conception and prototype phases and grows to over 89% in the other phases.

The average opening index also increases, but starts to fall again in the last phase (complete production of the product) due to lower commercial replicability and reusability.

In this stage the products are marketed by companies that are taking financial risks. This can make them reluctant to divulge information that facilitates imitation.

Maturity

- 1. Design
- 2. Prototype
- 3. Production/DIY
- 4. Production/Kit
- 5. Production/full product

Knowing the maturity level of the project could help in terms of research and development of the project itself

THE ROLE OF CONTEXTUAL CRITERIA

A second possible reason for the absence of published documentation **may be that the community which drove the product development is not active anymore.**

In that case there is not enough workforce anymore to maintain data online; links become “dead links” and information finally disappears.

This explanation tends to be supported by the gathered data, as the average openness index is significantly higher for products with active surrounding communities than for products with inactive communities (respectively 4.57 points and 2.91 points).

Status of the community

- ☐ Active
- ☐ Inactive

Knowing if the community status is active or inactive could help in terms of research and development of the project itself

THE ROLE OF CONTEXTUAL CRITERIA

We kept the categories identified by the research and we have added the FURNITURE category and the possibility to specify other possible category.

Product category

- ☐ Machine-tools
- ☐ Vehicles
- ☐ Robotics
- ☐ Agricultures
- ☐ Medical Equipment
- ☐ Musical Equipment
- ☐ Laboratory Equipment
- ☐ Toys and games
- ☐ Power Supply
- ☐ Furnitures
- ☐ Others _____

OPEN SOURCE HARDWARE LIFECYCLE

MODE 1

It appears from the reported analysis that the “source” of OSH tends to be interpreted in practice as a dataset whose contents and properties evolve along the product lifecycle. This is summarized in the open source hardware lifecycle.

This original framework defines two states of OSH characterized by specific motivations and shared product documentation as well as **two modes for developing open source hardware products.**

Within the product development process, an open source approach may be used as a means to support the emergence of community-based product development.

The OSH product is then before all the object of an open source product development process (Mode 1 in Figure).

Note:

At early development stages, Transparency can only be realized through the publication of descriptive text and simple schematics. Along the development of the product, stable technical drawings emerge (CAD files) which have to be shared in order to support further collaborative development.

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

Declaring the MODE with which the OS approach is adopted could help in terms of research and development of the project itself

M1

Mode 1

release

	Open Source Product Development	Open Source Product	
PRODUCT LIFECYCLE PHASE	Product development process	Production, Commercialization, Use, End of Life	
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	

redesign

OPEN SOURCE HARDWARE LIFECYCLE

MODE 2

Once a product is fully defined and can be produced, it can be documented as an open source product (Mode 2 in Figure).

In this case, open source is used to support the production and diffusion of the product and its durability (through reparability, modifiability and upgradability).

During the usage phase and at the product end-of-life, access to this same information may support the aspects of durability mentioned above.

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:

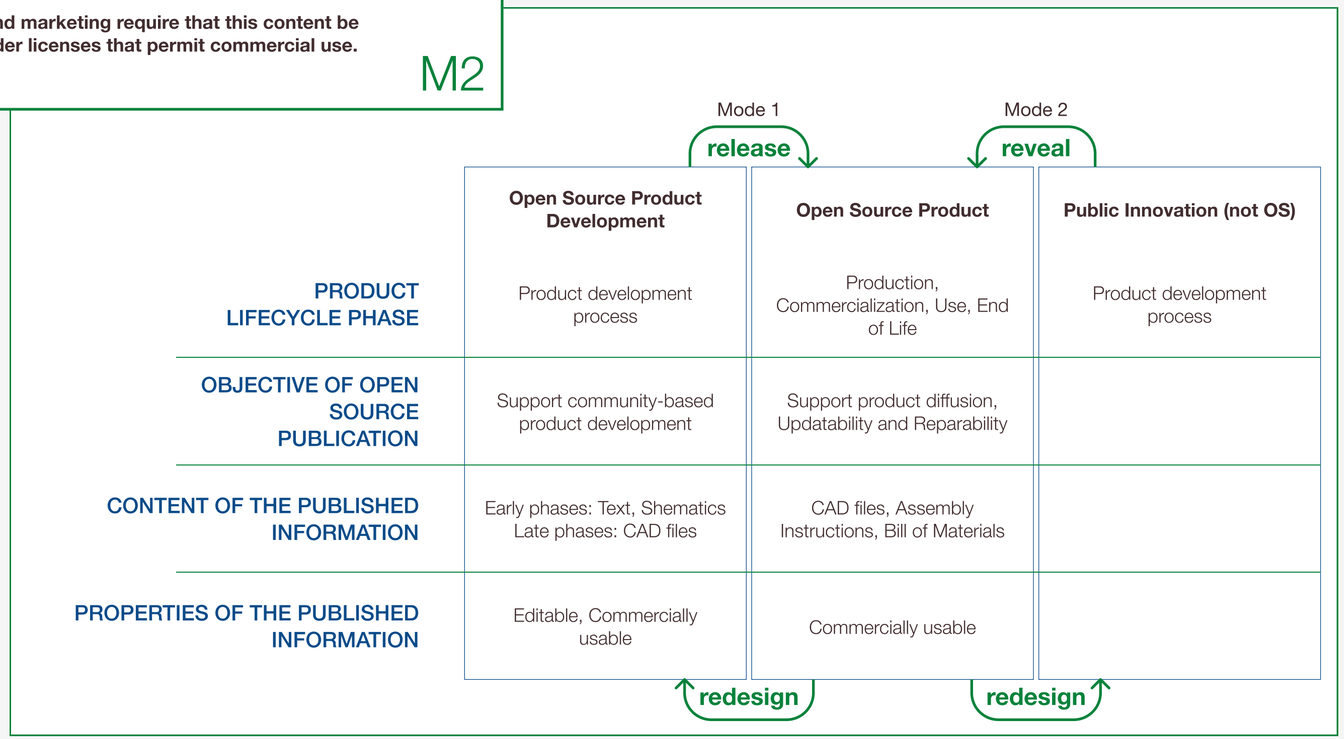
- **Bill of Materials**
- **Assembly Instructions**

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

M2

Declaring the MODE with which the OS approach is adopted could help in terms of research and development of the project itself

M1 M2



THE OPEN SOURCE HARDWARE LIFECYCLE

MODE 0

An open source product can either be the result of an open source product development process (mode 1) or of **the disclosing of documentation developed in a private setting-defined as public innovation** (mode 2) by Huizingh (2011).

Note that the latter **is not an open source development approach**, because it neither supports Accessibility (A) nor Transparency (T).

Upon the release of an open source product, the basis is made for new versions to be developed within any one of the two modes.

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.

OS MODE 0

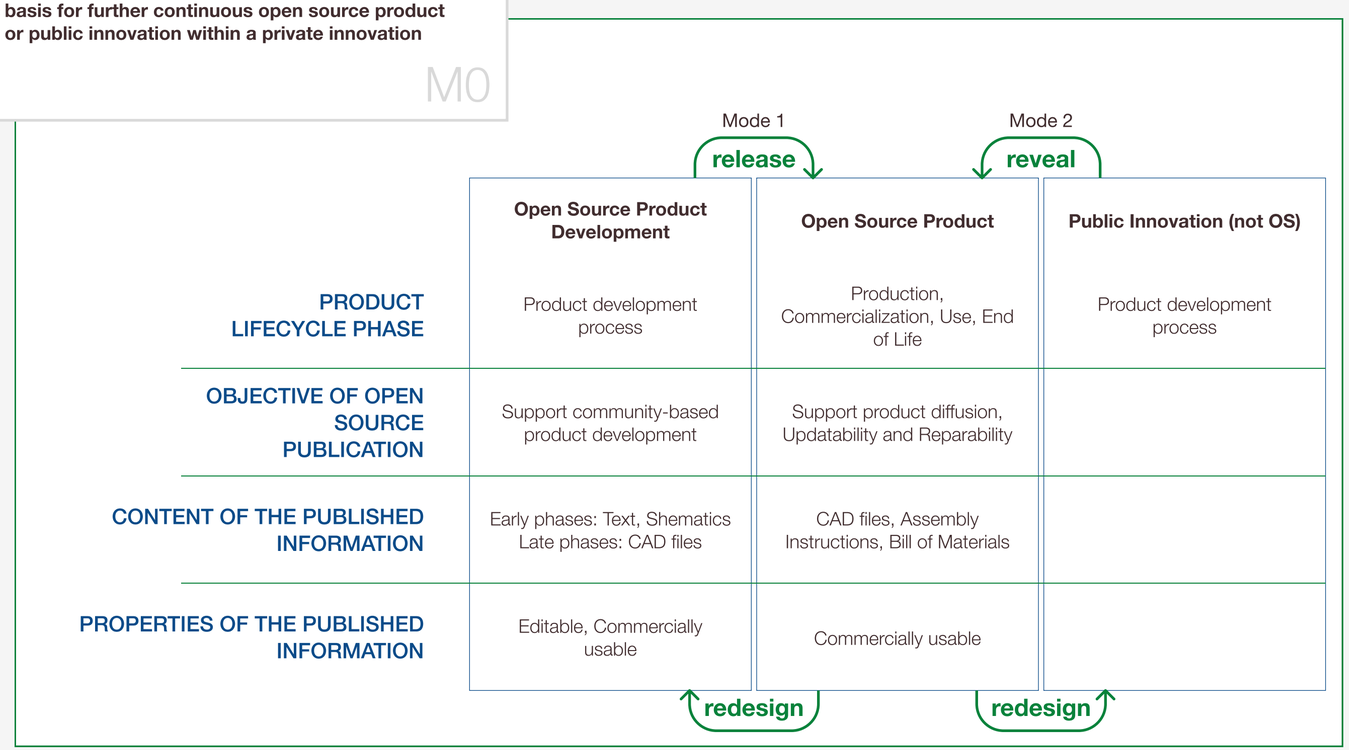
The disclosing of documentation developed in a private setting-defined as public innovation IS NOT an OPEN SOURCE development approach because IT NEITHER SUPPORTS:

- **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

It is also interesting to see that there is a “NO-MODE” of open source



THE OPEN SOURCE HARDWARE LIFECYCLE

NB:

The state “open source product development” has been previously termed in literature as **open source innovation** (Huizingh 2011; Raasch, Herstatt, and Balka 2009) and as **open design** (Balka, Raasch, and Herstatt 2009; Aitamurto, Holland, and Hussain 2015).

The state “open source product” is the result of either open source innovation or public innovation as termed by Huizingh (2011).

The lifecycle model is consequently in contradiction to an exclusive definition of OSH as a subcategory of open source innovation, as defined by Raasch, Herstatt, and Balka (2009) as well as Huizingh (2011).

This 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.

In those cases, however, labelling the product as open source would only make sense after a public release. An open source product development project as defined here may already fulfil the necessary requirements earlier.

We can’t fail to notice a missing case where we are witnessing a community-based Open Source Product Development process (M1) but at the same time a disclosure of the documentation developed in a private context, defined as Public Innovation (M2)

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 1 — release — Mode 2 — reveal

	Open Source Product Development	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	

redesign — redesign

LINK: http://doi.org/10.5334/joh.7

considerations MODE 3

This leads us to have to consider a hybrid mode, which in our case can be classified as:

- Academic Context (MODE 3)

Specifically, we can say that during the Design by Components 2022/2023 course we tried a direct approach to Open Design.

1. We consider Luxo (Brief) as the first Open Source product from which to derive other works.
2. Then we consider the students, professors, assistants, and various guest speakers as the community interested in the development of the product (Community by Components 2022/2023)
3. HOWEVER, we must consider the Community by Components 2022/2023 a private context, since the information was not accessible to people outside the community.

This has meant:

1. Development of products derived from a common brief
2. A continuous exchange of knowledge among community members (through reviews and Team Wheel and facilitated by the level of interpersonal ties)
3. Availability of produced material to community members (through a shared Dropbox) but not externally (T is met within the community)

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.

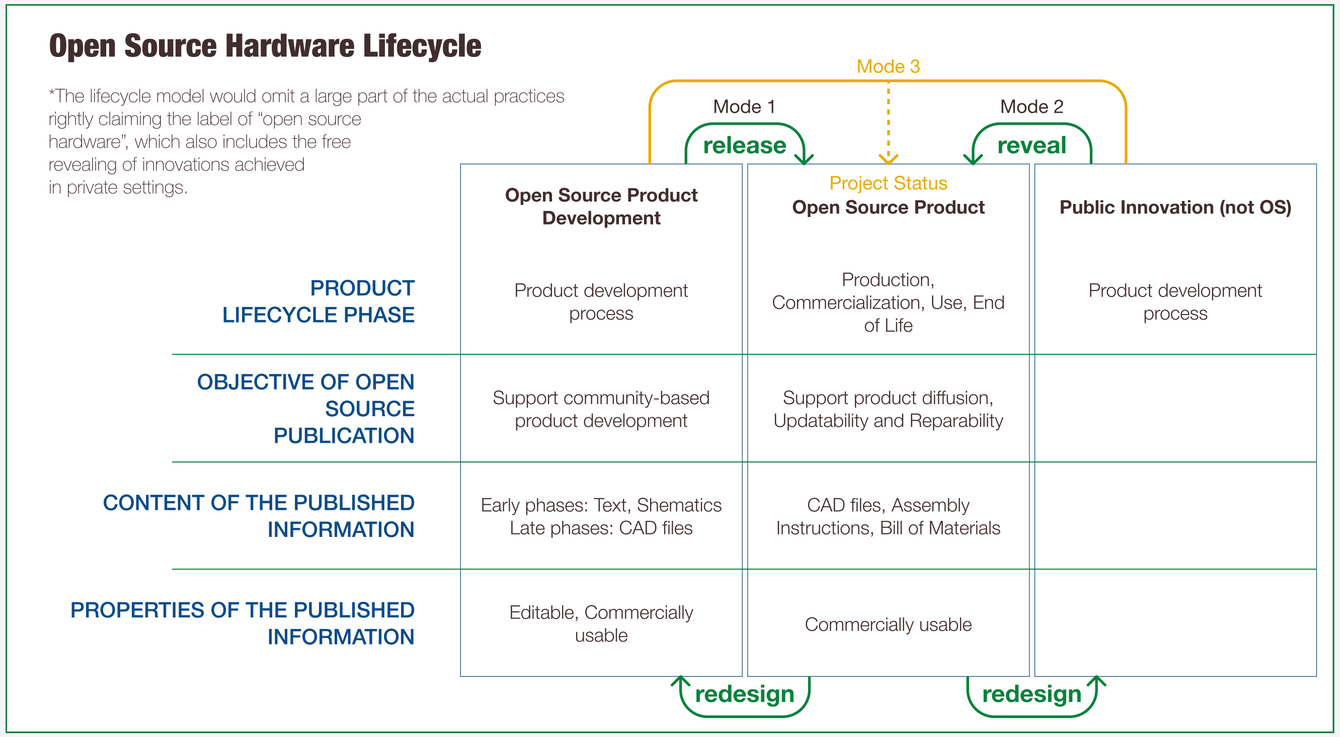
M3

THE OPEN SOURCE HARDWARE LIFECYCLE

Thus, it is to review the life cycle of an OSH product with the addition of a MODE 3 in which the product's OI changes from CURRENT STATUS to PROJECT STATUS.

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.



CONCLUSIONS OF THE RESEARCH

CONDITIONS OF EXISTENCE

The article provides an overview of how the concept of OSH is interpreted in practice, in other words, **what is the "SOURCE" of OSH for practitioners.**

What emerges from the analysed data is a multifaceted picture of OSH which confirms the existence of a **"confusion on what actually makes a project an open source project"** identified by Gacek and Arief (2004) in the field of OSS.
Product originators tend to make use of the large room for interpretation given by the fuzzy definition of the term "open source hardware", to pick up the openness factors best fitting with their situation and therefore to answer for themselves the question "what is the source of open source hardware?" in different ways.

The results highlight a surprisingly large share of products which are provided with barely any information at all (cluster C5, 18%).

This **could either be due to:**

1. **A misinterpretation of the concept of OSH**
2. **A deliberate intention to "openwash" a product**
3. **The influence of the time variable**

The reported research required the establishment of a database of OSH products which is the largest published to date.

This database provides empirical evidence of the evolution of OSH outside the sphere of electronics—a phenomenon which presently has only been described by scholarly publications based on isolated cases.

What can be understood from this is that **there is a need to set standards in order to achieve clarity in the field of OSH.** This will support the emergence of a constructive public discourse around these new practices.

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:

LIMITS OF THE RESEARCH

DEFINITION OF GOAL

The list of OSH products gathered for this study cannot be claimed to be exhaustive and its representativeness for the entire field of OSH has to be considered cautiously.

The authors also cannot exclude that the method used to search for eligible products may have omitted subsets of the field. Particularly product development projects which are in the early development phases may be more difficult to find because they are still poorly documented and their communities are relatively small, if there is any at all yet.

This may be the same for projects which acquired low publicity and are therefore poorly ranked in common internet search engines.

Nonetheless, the list of OSH products gathered for this study, with this focus, is the largest that has been published so far.

Additionally, the broad field of OSH was narrowed down to discrete, tangible, non-electronic and complex products, which excludes a large part of the field (such as millions of gimmicks).

In terms of how far the results discussed in this article are valid for the whole range of OSH products, including low complexity products as well as purely electronic products, remains an open question.

Further research could make use of the methods defined in this article in order to perform a similar analysis specifically addressing electronic hardware.

To the knowledge of the authors, no such a study has been published so far. The OSHWA maintains a list of certified OSH products, most of which are electronic products, providing therefore an interesting data basis.

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.

G1

GOAL 2

G2

LIMITS OF THE RESEARCH

GOALS

The assessment of the corresponding published product-related documentation has been simplified to the evaluation of binary criteria. Each product was assessed as to whether certain types of documents are provided. The quality of the published documentation with regard to the level of detail, comprehensiveness or clarity has not been examined.

- Do published CAD files represent the whole product or just parts of it?
- Are the guidelines for participation easily understandable for potential participants and provide them with the right information?
- What information is displayed in parts lists and in what form?

These questions were not taken into account because of the need to reduce the data acquisition effort to a manageable level.

This simplification may have produced a positive bias, whereby products may have been rated more open than they are.

Future research is needed in order to define to what extent published product-related documentation is actually USABLE and USEFUL.

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

DEFAULT OPENNESS FORM

This data highlights a certain heterogeneity of practices in the publication of OSH product documentation.
The large majority of products show diverse profiles of partial openness without clearly identifiable patterns.

We try to facilitate the traceability of the various factors with **the aim of helping the research and debate around Open Design.**

Accessibility seems to correspond to greater effort. As It is a precondition for the emergence of a community-based co-development process, **we want to to set out clearly the possible choices for its achievement.**

Considering what was said in the note on page 3, i.e. that assembly instructions or the Bill of materials may be irrelevant, **we need to consider a further degree of detail also in Replicability* (R*).**

Note:

Integrating contributions from a development community implies significant coordination costs and requires dedicated resources. As accessibility supports a process which is difficult to implement in practice, not all product originators may give this aspect a high priority.

***If you think it is irrelevant information, please specify how you satisfy this factor.**
*pag 3

R

HOW OPEN ARE YOU?

M1 | M2 | M3 CS | M3 PS

a CAD files available — T

b CAD files editable — A

c Assembly instructions available — R

d Assembly instructions editable

e Bill of materials available

f Bill of materials editable

g Guidelines for participation

cc Assembly instructions irrelevant*

ee Bill of materials irrelevant*

*please specify how you satisfy **R** factor

R*

h Commercial usage allowed

i Licence — C

- ☐ 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)
- ☐ YES (Mechatronic Product)
- ☐ Mechanical Process
- ☐ Electric Process
- ☐ Electronic Process

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 _____

DEFAULT OPENNESS FORM

INSTRUCTIONS

YOU CAN'T select one of the criteria **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.

HOW OPEN ARE YOU?

M1 | M2 | M3 CS | M3 PS

a CAD files available — T

b CAD files editable — A

c Assembly instructions available — R → d Assembly instructions editable

e Bill of materials available → f Bill of materials editable

○ ○ ○ ○ ○ ○ ○

g Guidelines for participation

cc Assembly instructions irrelevant* — R*

ee Bill of materials irrelevant*

*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)
- ☐ YES (Mechatronic Product)
- ☐ Mechanical Process
- ☐ Electric Process
- ☐ Electronic Process

k Maturity

- ☐ 1. Design
- ☐ 2. Prototype
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- ☐ Laboratory Equipment
- ☐ Toys and games
- ☐ Power Supply
- ☐ Furnitures
- ☐ Others _____

DEFAULT CODE

D0

On page 11, we say that the **k-medioids algorithm** (or PAM, Partitioning Around Medioids) has been used since it is particularly **adapted to the clustering** of objects described by categorical data.

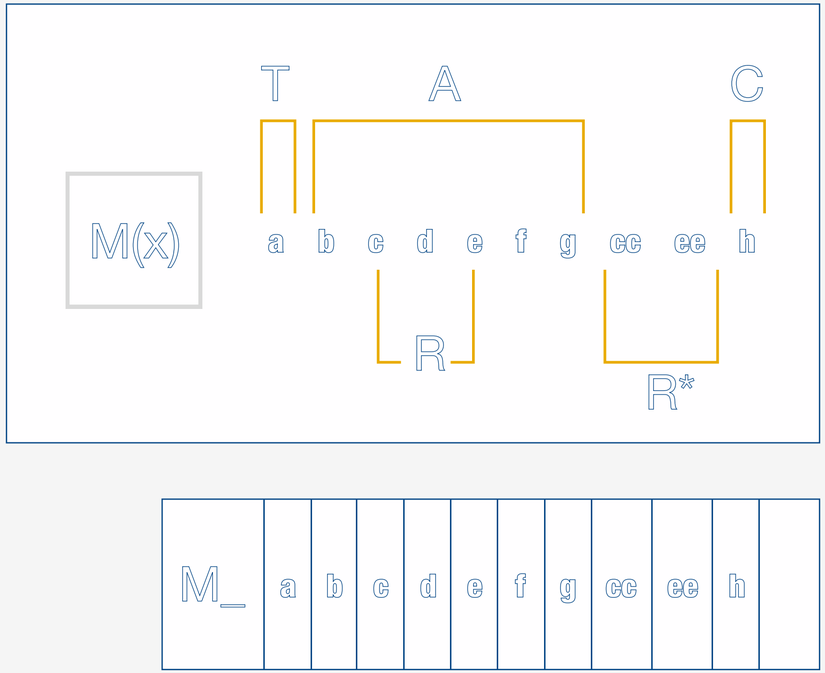
It is recommended to consult the direct source and perhaps to deepen this aspect with more competent people.

A first stage of form is thus defined.

An alphabetical code will come out of this, which could not only HELP RESEARCHERS TO SPEED UP DATA ANALYSIS, but also DESIGNERS TO UNDERSTAND THE PROGRESS IN TERMS OF "OPENNESS" TO THE CURRENT STATUS AND THE PROJECT STATUS.

THE CONTEXTUAL CRITERIA ARE TO BE CHECKED DIRECTLY IN THE FORM.

It can always be modified in the future based on new criteria and/or new needs.



Note:

Each product is represented by a binary word of 8 bits—each bit representing a criterion from a to h (as described in equation 3). Inter-product similarity is computed according to the Manhattan distance (? need to consult a PRO)

HYPOTHESIS OF NEW CLUSTERS

In order to facilitate the visualization of the level of openness that can be reached, new clusters could be hypothesized.

For now, we have hypothesized this Clustering only as a tool intended to help DESIGNERS in the design phase to recognize the various levels of openness and stimulate discussion.

Further investigation and initial feedback of using this approach would be needed for research.

If you recall, on p. 14, we added a further distinction between Products, which contain electronic or non-electronic parts, and Processes, which require Mechanical (low-medium), Electrical (medium-high) and Electronic (mainly high) skills.

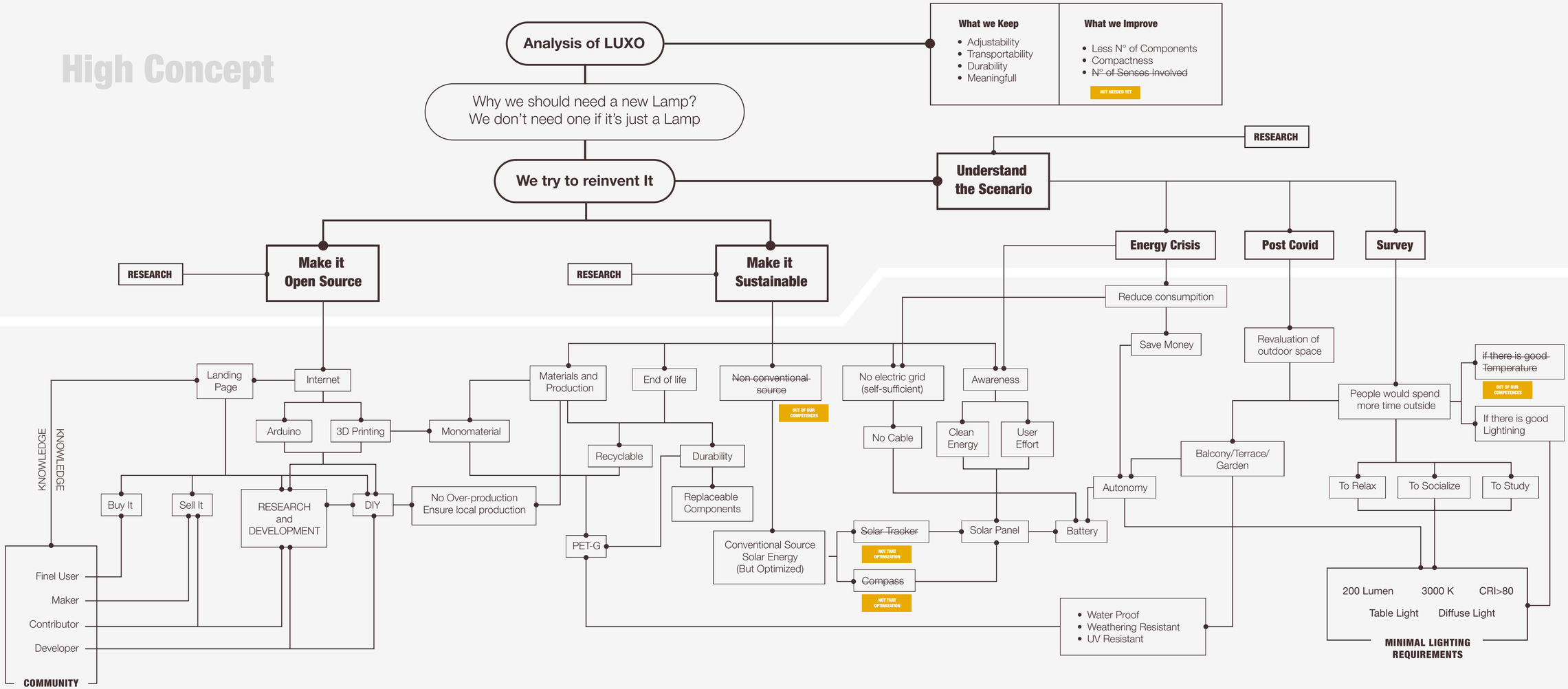
How can I share this information?

I try to outline the PROCESS (in a consequential flow) that led from the Brief to an initial High Concept from which the Concept Design then developed

1

Never mind the detail as this will be described in other documentation!

DEFAULT OPEN DESIGN PROCESS



Concept Design → Prototype

2

I try to classify the STAKEHOLDERS of THE PROJECT according to their qualitative interest.

Then I identify the possible skills needed to carry out a certain process and compare them with the skills of the STAKEHOLDERS (PROJECT STATUS).

Never mind the detail as this will be described in other documentation!

(ANOTHER RESEARCH)

To understand this, we found another research study in particular helpful:

“Open source enters the world of atoms: A statistical analysis of open design” by Kerstin Balka, Christina Raasch, and Cornelius Herstatt is licensed under a Creative Commons Attribution–Share Alike 3.0 Germany License.

Paper received 10 September 2009; accepted 9 October 2009.

It served us to better understand the OPEN SOURCE SYSTEM. and divide it into 6 MACROAREAs.

Actors

- The size of the communnity is positively correlated with the progress of the project. On the one hand one might guess that projects tend to grow over time and that it might be easier for successful projects to attract considerable attention from the wider developer community; on the other hand a larger community could carry on the development.
- The participation of commercial contributors is positively correlated with the progress of the project.

Open source products are generally suitable for end users, advanced users and developers.

- Different backgrounds
- Non-separate categories

Object

- No strong evidence can be found that indicates that low or high completixy products are better suited to open source development. All levels of complexity are addressed by opene design projectsi.
- Complex objects are often modularized into manageable pieces and developed separately.
- Participants make a great effort to enable digital design and developement as much as possible. Hardware development plays the major role whiile software development takes a back seat, but it remains important to control the functionality
- The development of 3D printers, CNC cutters, and similar tools for home use increasingly allows developers to produce their designs independently of a central manufacturing facility. With the emergence of communities around the equipment needed to share expenses and facilitate access, deentralized manufacturing becomes increasingly accessible.

Therefore, a focal manufacturer supplying the products is no longer a neccessity, and open physical product development becomes even more like OSS development

(ANOTHER RESEARCH)

Governance Structure

- It cannot be said that projects distributed under very restrictive conditions are less likely to reach an advanced stage of development. Commercial actors seem to prefer to protect their work by registering the project name, which is less common for private or research actors.
- Rather, there is a positive correlation between brand protection and late stages of development, and an interrelationship between the release of unlicensed information and small projects in the early stages of development. Both the absence of licensing and the complete openness could reflect a general absence of intellectual property strategies which seems to reduce the size of the community and is rarely observed if commercal actors are involved,

Projects developing highly complex products appear, or at least expect to achieve more innovative results and attract commercial contributors

Innovative Result

- No storng evidence can be found to indicate that targeting advanced audiences is positively correlated with project progress. Open design is applied to the full spectrum of innovativeness, from the generation of incremental to radical innovations, with a greater proportion striving for incremental or intermediate degrees of innovativeness
- Larger projects reach higher stages of progress or, conversely, projects grow as they mature. Most projects have not fully completed development, but around 50% have reached a stable production stage and are commercializing their products

Projects with a large community, which includes commercial players or even is organized by professionals, have a high probability of reaching advanced stages of development.

Development Process

- Activity is positively correlated with project progress. Strong correlation between the intensity of developer activity and the stage of development.
- OSS projects and open design projects with higher activity tend to be in more advanced stages of development. In both fields, more research is needed to arrive at conclusions on the impact of prcess design on project success.

In 70-80% of projects, product development is driven by private contributors, i.e. the project leader, core team or even the wider community with no dedicated authority.

In about half of the respective cases this group also acts as a producer, the second half interacts with a production and marketing support company

Environment

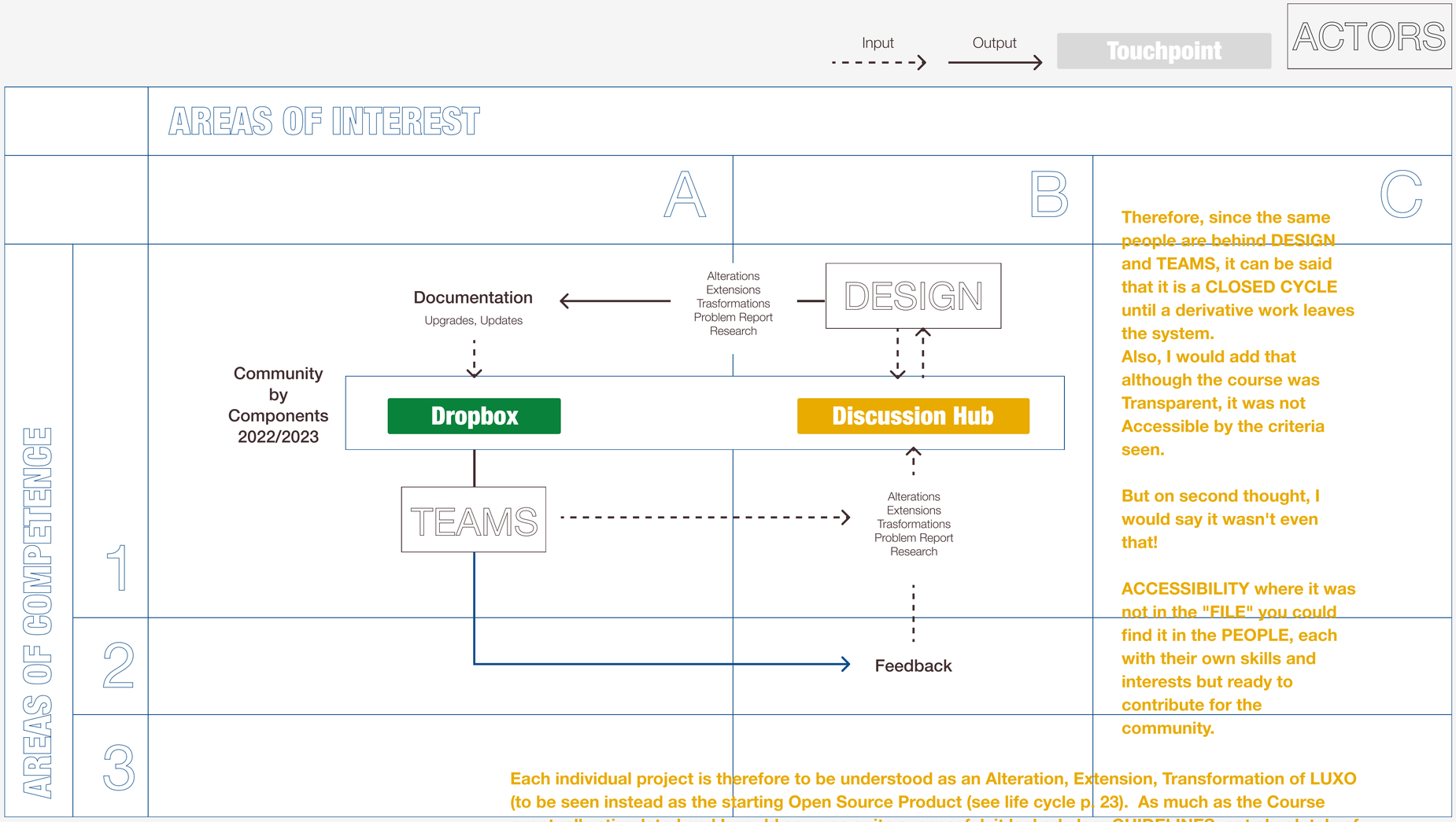
- The internet is the main support tool for the low cost developer community. The most common means of communication are mailing lists, chat rooms and discussion forums
- OD products are very attractive to open source software enthusiasts. Developing these products not only typically involves a great deal of software development, but many of these products are also software modelable

In some cases it is observed that the absence of required tools slows down the entire developement work.

DEFAULT OPEN DESIGN SYSTEM

CURRENT STATUS

NB: "DESIGN" refers to "PROJECT" and NOT to "PRODUCT." It would seem strange to put it among the ACTORS, but I think one should understand the interest of the project before that of the DESIGNERS behind it. In fact, if in INPUT we are indeed DESIGNERS, in OUTPUT we tend to come back as USERS and show more personal interests (to say one, remuneration/COMPENSATION) rather than COMMUNITY interests (to say another, ABBACING CONSUMPTIONS/FAVORING LOCAL ACTIVITIES/ CHANGING THE SYSTEM....and all those nice things we tell each other in the design phase).



Therefore, since the same people are behind DESIGN and TEAMS, it can be said that it is a CLOSED CYCLE until a derivative work leaves the system.
Also, I would add that although the course was Transparent, it was not Accessible by the criteria seen.

But on second thought, I would say it wasn't even that!

ACCESSIBILITY where it was not in the "FILE" you could find it in the PEOPLE, each with their own skills and interests but ready to contribute for the community.

Transparent but NOT Accessible

Updates
(Presentations, file PDF)
Upgrades
(Presentations, file PDF)

The "GUIDELINES FOR PARTECIPATION" (g) defining the meaning of USEFUL AND USEFUL DOCUMENTATION is missing.

Knowledge Exchange

- Lighting
- Research and Development
- Problem Report
- Design by Components
- Chemistry and Manufacturing Processes
- Mechanics
- History of Material Culture

"WHAT YOU NEED?" - A HELP - A SPRITZ!

COMMUNITY

Each individual project is therefore to be understood as an Alteration, Extension, Transformation of LUXO (to be seen instead as the starting Open Source Product (see life cycle p. 23). As much as the Course eventually stimulated and I would say was quite successful, it lacked clear GUIDELINES, not absolutely of course, but explaining well the mode of participation and the concept of "USEFUL AND USABLE DOCUMENTATION"

Based on The Bakery team_"Structure of an Open Source Product"_review 18/11/2022", available on the community Dropbox_
*If in doubt, ask CIC

CLASSIFICATION SCHEME OF STAKEHOLDERS BASED ON SKILLS

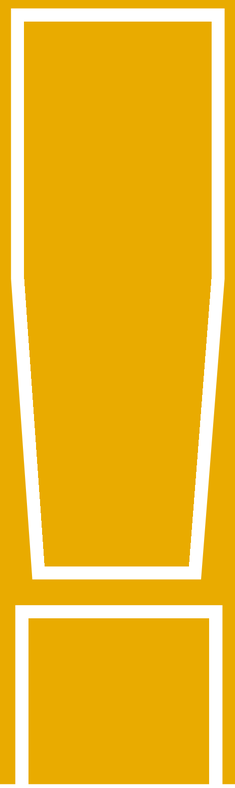
PROJECT STATUS

AREAS OF INTEREST	A	B
	• Updates • Upgrades	• Lighting • Research and Development • Problem Report • Design by Components • Chemistry and Manufacturing Processes • Mechanics • History of Material Culture A HELP - A SPRITZ!
AREAS OF COMPETENCE	1	2
NECESSARY SKILLS	• Upgrades • Updates	• FEEDBACK
APPRECIATED SKILLS	• FEEDBACK	• “WHAT YOU NEED?”

By providing guidelines for participation, it is assumed (if the various considerations are right) that anyone who adheres to these GUIDELINES can indeed be called open in that they meet the criteria of Transparency (T) and Accessibility (A).
As for Commercial Usability (C) is to be considered, being in MODE 3, it is not measurable.

DESIGN	B1
TEAMS	/

*If in doubt, ask CIC

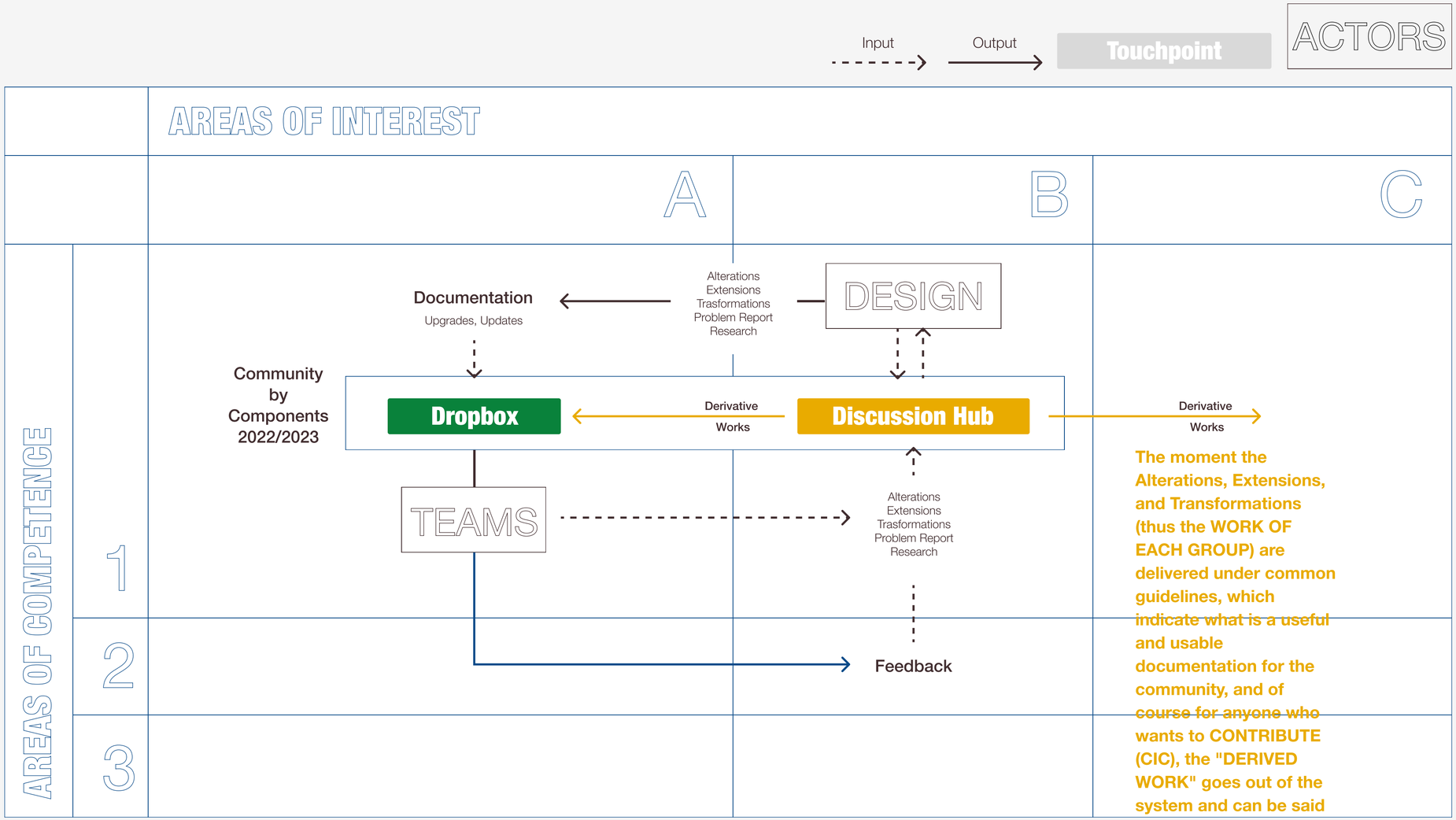


HOWEVER, by placing a LICENSE on the GUIDELINES themselves, allowing them to be usable even commercially, we could conclude that this document is a "derivative work" of the Community by Components 2022/2023 based Product development process and therefore any "DERIVED WORK" of this document should also be considered OPEN.

LICENCE AND THANKS

DEFAULT OPEN DESIGN SYSTEM

CURRENT STATUS



Transparent but NOT Accessible

Updates
(Presentations, file PDF)
Upgrades
(Presentations, file PDF)

The "GUIDELINES FOR PARTECIPATION" (g) defining the meaning of USEFUL AND USEFUL DOCUMENTATION is missing.

The moment the Alterations, Extensions, and Transformations (thus the WORK OF EACH GROUP) are delivered under common guidelines, which indicate what is a useful and usable documentation for the community, and of course for anyone who wants to CONTRIBUTE (CIC), the "DERIVED WORK" goes out of the system and can be said to become effectively OPEN

Knowledge Exchange
- Lighting
- Research and Development
- Problem Report
- Design by Components
- Chemistry and Manufacturing Processes
- Mechanics
- History of Material Culture

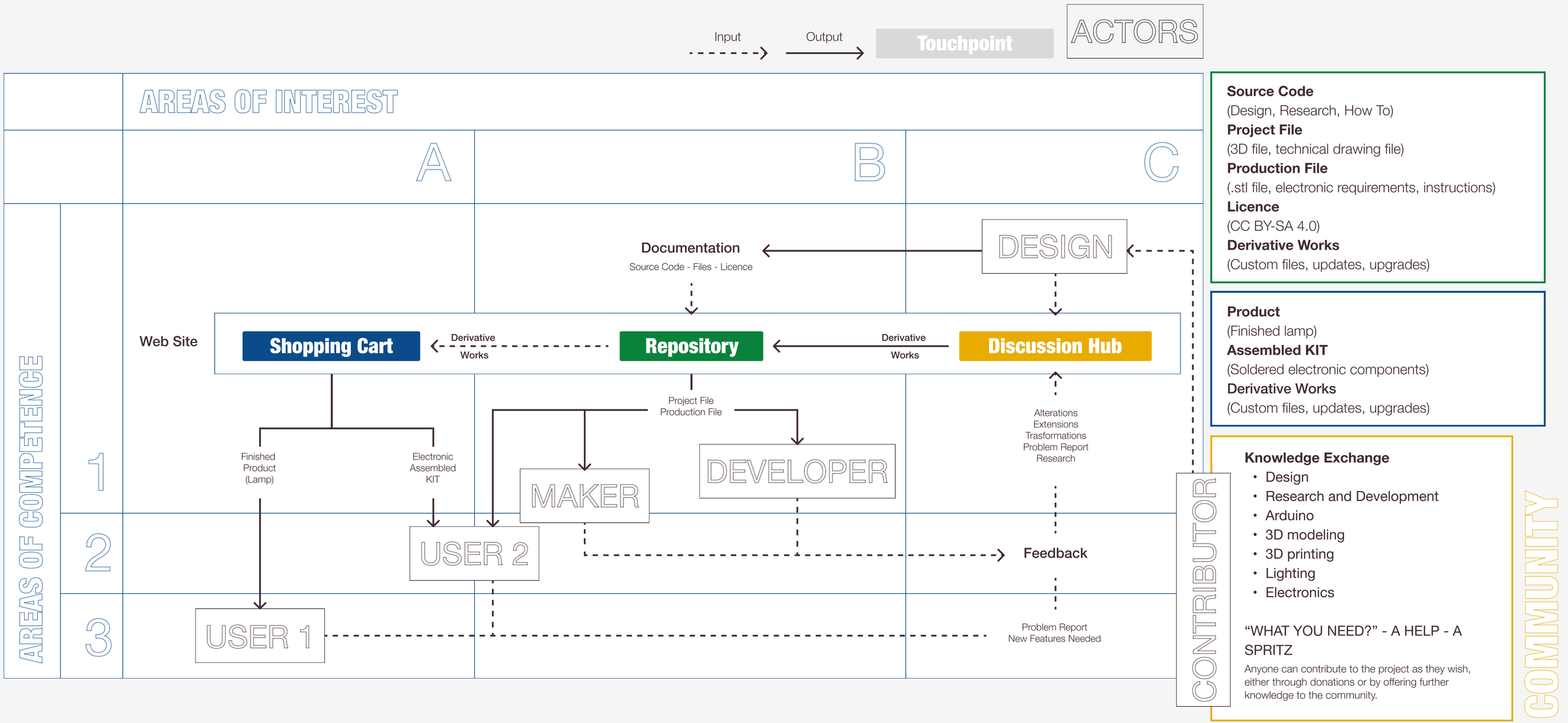
"WHAT YOU NEED?" - A HELP - A SPRITZ!

COMMUNITY

*If in doubt, ask CIC

DEFAULT OPEN DESIGN SYSTEM

PROJECT STATUS



Source Code
(Design, Research, How To)
Project File
(3D file, technical drawing file)
Production File
(.stl file, electronic requirements, instructions)
Licence
(CC BY-SA 4.0)
Derivative Works
(Custom files, updates, upgrades)

Product
(Finished lamp)
Assembled KIT
(Soldered electronic components)
Derivative Works
(Custom files, updates, upgrades)

Knowledge Exchange

- Design
- Research and Development
- Arduino
- 3D modeling
- 3D printing
- Lighting
- Electronics

“WHAT YOU NEED?” - A HELP - A SPRITZ

Anyone can contribute to the project as they wish, either through donations or by offering further knowledge to the community.

*If in doubt, ask CIC

CLASSIFICATION SCHEME OF STAKEHOLDERS BASED ON SKILLS

AREAS OF INTEREST	A	B	C
	• Product • Assembled KIT • Derivative Works • Spend more time outside	• Source Code • Licence • Project File • Production File • Derivative Works	• Community Building • Knowledge Exchange • People spend more time outside • Reduce Consumption • No Over-Production • Ensure Local Production
AREAS OF COMPETENCE	1	2	3
NECESSARY SKILLS	• 3D printing • 3D modeling • Basic Electronics	• 3D printing • 3D modeling	• Internet User (or get in touch with It)
PRO SKILLS	• Arduino • Lighting		
APPRECIATED SKILLS	• Design • Research and Development	• Design • Research and Development	• Design • Research and Development

DESIGN	C1
MAKER	B1/2
USER 1	A3
USER 2	A/B2
DEVELOPER	B1
CONTRIBUTOR	/

NB:

***You become a CIC when you start following these GUIDELINES.**

I hope, despite i talked your ear off, that I have also made people smile. here and there :-

Apri Tutto”

CIT. BORIS (la serie)

Smarmella g

Open Guidelines for Partecipation

a **DERIVATIVE WORK** OF Design by Components course 2022/2023