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Economy and community as bottom-up drivers for design: creating coordinating dashboards for architectural design.

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Economy and Community as Bottom-Up Drivers for Design

Creating coordinating dashboards for architectural design

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In our paper, we show that, from an economic and environmental point of view, neighbourhoods could benefit from a circular architectural design approach, as creating an actual circular economy and community asks for more organisation than purely spatial planning. By using design as a driver both for a self-sustained economy and for architectural design, we provide a pathway for architects to be involved beyond their singular architectural design outputs We believe that our paper is significant in developing alternative, bottom-up mechanisms for developing and managing architectural designs and its afterlife. The dashboard and digital infrastructure developed through the paper can also be used by other researchers to expand the cases where our method can be applied.

Keywords: *Blockchain, Common Pool Resources, Stigmergy. Ostrom Principles.*

INTRODUCTION

Traditional design methods are still very present in applied architecture, which results in a system of delivering a product rather than designing a building that can adapt to people's needs. This linear thinking systemically separates the built artifact from the living economy, failing to use the strength of architecture's ability to holistically design a strong, progressive entangled economy and community. The linear architectural design approach includes a certain end date at which the architect and the architecture will split up. The future of the project will thus disappear from the architect's responsibility, which might result in neglect of the original goals and intentions such as social cohesion, sustainability, maintenance or efficiency. The lifespan, purpose and adaptability of a building are of equal importance to the design and the delivery, yet these issues are neglected in a linear architectural design approach. Design approaches should therefore aspire to be more circular. This paper presents the design of a process and a digital toolset that simplifies the links between the different phases of building design and building usage, by looking further than architectural design and involving environmental, economic and social processes [Hunhevicz et al 2020, Brekke 2020]. This results in narrowing the gap between design and long-term needs. We have tested our tool, a bottom-up, decentralised, dashboard, based on a case study, to test whether it is possible to design a circular economy hand in hand with designing a specific building. This process ran parallel to a 3D architectural building design and creating diagrams of ecosystem and community flows.

RESEARCH METHODOLOGY

We present a blockchain based system with which communities can develop the architectural design they need and then further manage the resulting operation of the community and the building, inspired by the idea of the commons [Hunhevicz et al 2022]. To do so, we frame design activity and the resulting utility from the design artefact, as a common pool resource system (CPRS), regulated by economic principles defined by Elinor Ostrom, the health and growth of which is monitored and governed by a blockchain system and smart contracts [Manski, S et al. 2020].
This leads us to the following research questions:

1. What should be the interplay and interdependence between architectural design, (circular) economy and community building, leading to circular architectural design approaches, of high quality?
2. How does design as an activity extend from architectural design to the economy, and with which tools can we visualise the interdependence?

CASE STUDY

Starting from a case study, we used three different representation tools, to design a coherent mechanism of interdependence. As such our methods are based on Design for Research, extending partially as Design Science Research (DSR), in the part of the economy and dashboard. In terms of constraints, we have only preliminary tests of our prototype. Still our methods diverge from DSR in the sense that we include in testing not only the dashboard prototype but also the architectural design of the building. [Majchrzak, A 2020]

The Blikfabriek

We have selected the site of the Blikfabriek in Antwerp, Belgium, as our site for the analysis and design of the case study. The site is located in Hoboken, a district south of Antwerp's city centre that went through an interesting industrialisation process as part of the expansion of the Port of Antwerp. In the 19th century, various crafts and metallurgic companies took over the area, with the working class settling within the surroundings of the factories. This resulted in a small industrialised community with housing, work and recreation.

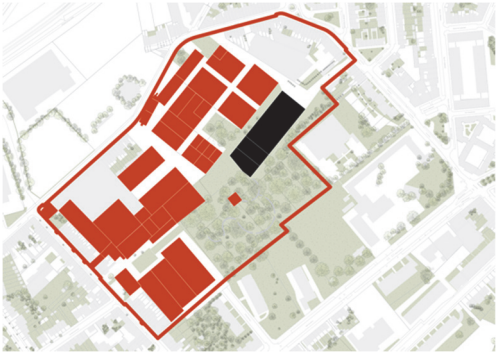


Figure 1
Figure ground of the site, Blikfabriek and project

The project site encompasses some of the now deserted factory building structures: an area that poses many unresolved questions in terms of property, ownership and spatial planning. The ensemble, covering an enormous footprint of more than 90000 square meters, manifests as an enclosed and impenetrable mass of built and non-built. The historical sequence of concatenation results in a patchwork of structures, mostly constructed from steel skeleton and not spatially structured.

One third of the site has been appropriated by an organisation called the 'Blikfabriek', named after the can factory Crown, one of the former factories on site. The appropriation results in temporary structures within the factory structures, being a space for creativity and entrepreneurship. Combined with a local hub, meeting spaces, activities and a neighbourhood café, the Blikfabriek serves the community with shared facilities, social life, and a culture of their own circular economy. The industrial history, empty structures and current creative and circular spirit of the neighbourhood, prepares the rest of the site for a new circular architectural design approach that includes long-term economy creation and community building.

For the case-study, we repurpose an existing steel structure of 6200 m^2 ('the project') on the site, on walking distance from the Blikfabriek. In the rest of the site, we operate under the assumption that a larger masterplan for the revitalisation of the site will be executed. As a reference, we follow the masterplan developed by last-year architecture students at the University of Antwerp. This masterplan includes housing for vulnerable people, creative spaces, meeting spaces, offices for small local businesses, etc.
The site, the Blikfabriek, and the project (in black) are visualised in Figure 1.

Methods

Instead of taking a linear architectural design approach with re-used materials from the site, we propose a new design through a circular architectural design approach, driven via material and values flows, as envisoned through feedback loop diagrams. The feedback loop diagrams constitute the computational design tools that inform the design of blockchain tokens and the architectural design. We simultaneously design the architecture of the project, a potential economic system and its associated community [Dounas et al 2019]. Our design principles could later be extended to the whole site, following the masterplan. The members of the Blikfabriek are involved in the design process, acting as experts of their own local circular economy and community.

Our proposed circular architectural design approach consists of three simultaneously developed parts. We designed a bottom-up, decentralised, dashboard as a tool to model the circular economy and community. We pair the dashboard with diagrams that simulate the flows within the project (e.g. value flows, material flows, social flows, etc.). We use Loopy (Case, 2017) for the flow diagrams, as it comes with an interactive feature that visualises the flows over time, to see what effects certain actions have. In practice, this means some of the parameters within the diagram can be selected to add a certain value into the diagram. What happens next is an ongoing repetition of live continuous looping, out of which we can conclude effects and results based on those initial parameters which added value. We also use 3D architectural modelling software to design the architecture, focusing on the spatial qualities of the project. This parallel approach allows us to research whether the dashboard is an appropriate tool to design a communal architecture with an economic backbone.

Figure 2
Home screen of the blockchain based dashboard

Dashboard

In order to coordinate all operations taking place within the project, a blockchain based dashboard (as visualised in Figure 2) must fulfil all digital-steered demands. This regards planning, smart contracts,

governance rights, forums, tokens, inventories and so on. It could be seen as a virtual community in which everything is kept track of. We have elected to use blockchain for the backend, as the technology allows the creation of peer-to-peer digital economies including the creation of fungible and non-fungible tokens, enables radical transparency of operations and supply chains, is an excellent fit for a circular economy, and shifts trust to the computing protocol. As such, both internal and external stakeholders can engage with the project, investing, or contributing through labour or materials.

Our aim is to streamline all flow-related aspects of the site to enhance flexibility and user experience. Inhabitants can easily connect with local makers, join, learn from them. These makers can on the other hand utilise the community's infrastructure. Up-cycling is nearby and the whole neighbourhood can take advantage of this opportunity to keep materials close and take care of existing objects and its whole lifecycle.

The dashboard itself, next to the Home screen and Tokens-platform, consists of several data-driven buttons, in order to stimulate and optimize the community. Each button drives a concrete idea, determined by the main design decisions. The Events button contains a calendar in which workshops or collective discussion sessions, or other events can be planned. The Material market contains an inventory with a stock overview and collection moments, allowing a transparent and accessible workflow. The Blik barometer gives an overview of each of the functions within the project, provided with their economic activity. With the Maintenance button, community members can either ask for, or provide maintenance assistance. The Forums button offers a social feature for the community to share common issues or interests. Behind the Investments button lies a series of recent and upcoming collective investments, connected to their status. Here, anyone has the possibility to create and vote new investment proposals. Urban Farming gives an overview of the planning, regarding the seeding-, weeding- and harvesting calendar. People are able

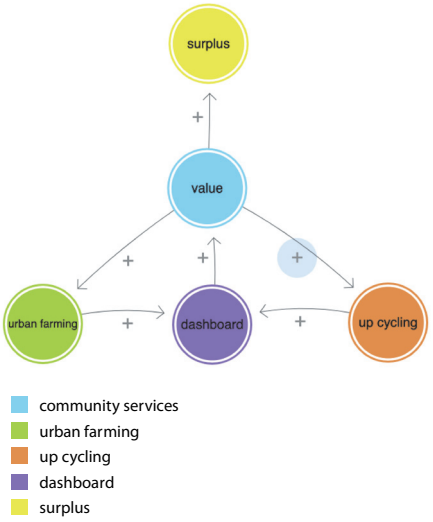


Figure 3
Base principle
Loopy diagram

to join or invite on these chores and a real-time follow up of humidity and temperature is also a feature. The Up-cycling sign provides a real-time list of the material batches and shows the ongoing processes. Local makers contain buttons for each business, linked to their websites. There is also one simple button that offers the facility to Rent a space, for various time periods and of different kinds. Logistics, notifies for deliveries in the collective mail unit, and it allows the organisation of shared mobility on-site. The Tool inventory is a platform for the community to share tools instead of buying them individually. Moreover, the Tokens screen facilitates having a local coin, which either determines the value of the community economy, but also gives people the opportunity to create their own independent market within the community.

Loopy diagrams

By creating Loopy diagrams on the same scale as the project focus, these diagrams can be applied to the project. We first modelled a base principle, shown in Figure 3, of volunteering community members with the same intentions and interest in their own

Figure 4
Urban farming
Loopy diagram

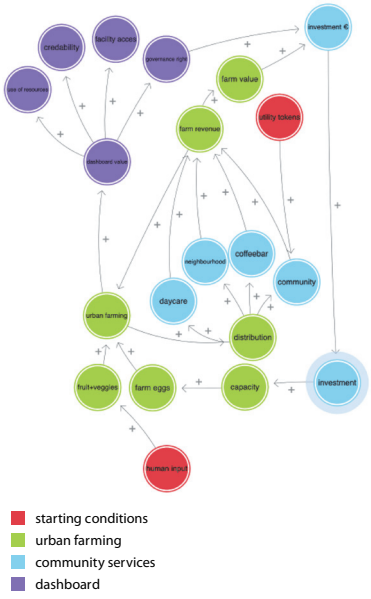


Figure 5
Up cycling Loopy
diagram

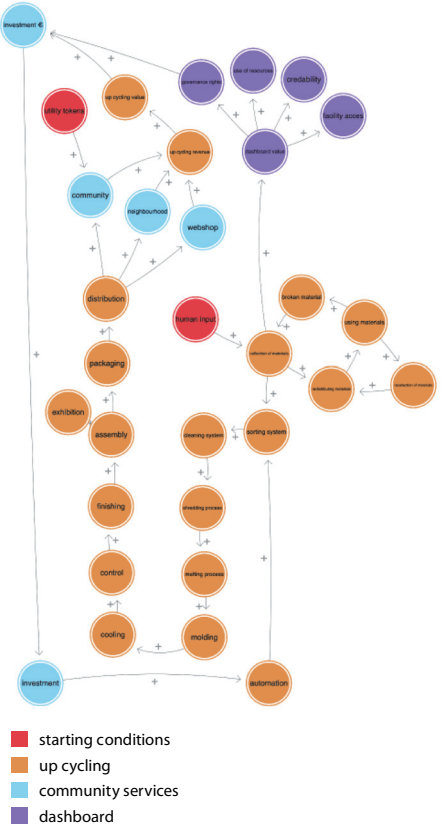
economy [Li et al, 2019]. We used urban farming and an up-cycling mechanism as main engines of the economic system (see Figure 4 and 5). These two examples both start from second hand or discarded resources with low value and make a product out of it. To create value, the project coordinates infrastructure and offers services such as a nursery, a coffee bar, a social hub and makerspaces (Figure 6). These services can be accessed by the whole neighbourhood. Combining production with the public good, a system occurs in which the community's welfare is directly affected by the amount of activity.

Implementing a non-extractable token, all members of the community will directly benefit from all effort an input, using a virtual reflection of the whole system on the dashboard [redacted xxxx 2021].

By considering 3 different approaches to get the economic activities started, the Loopy diagrams can start a loop:

1. implementing utility tokens
2. human input
3. investment in euro

We will refer to these three approaches as the starting conditions for the system.



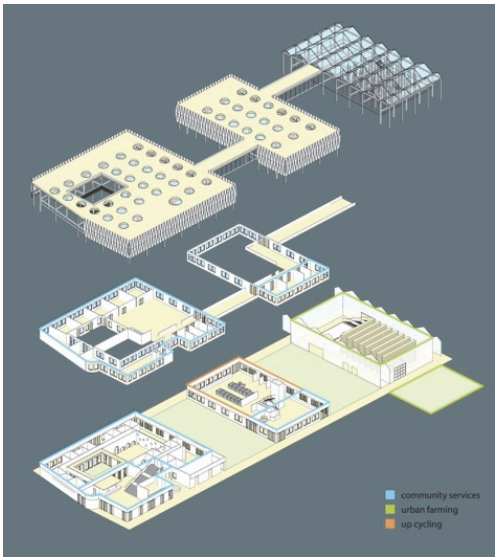


Figure 6
Axonometric view of the project

Firstly, implementing utility tokens (which would mean creating a starting capital of the community's token), is a first approach. This way community members are being encouraged to contribute to the local economy and support small businesses.

Secondly, starting from human input means counting on community volunteers. This requires a committed community with individuals who can run a local business and are willing to invest time, before having capital to reward extern individuals.

Lastly, investments in euro (providing an actual amount of money to start the economy), requires people willing to invest and they preferably must be part of the community, to accomplish a decentralised system.

The next section describes how urban farming and up-cycling have been used as main engines for the project. First of all, the urban farming is an accessible economic model, meaning there are not too many technicalities when starting. This however, could change once there are resources to expand and for example invest in hydroponics or an additional egg-farm, (Figure 4). People are mainly accountable for the value of the economy. The farmed products can be used by inhabitants, the coffee bar, the nursery, but also by people living outside the administrative boundaries of the site. As visualised in purple (Figure 4), the dashboard connects the flows, for example being important in the governance system deciding on investments. Secondly, the upcycling process is somehow more complex, but also accessible. The outdated idea of dropping off everything at the recycling park and outsourcing all up- and recycling in exchange for payment, can be replaced by a transparent in-house process. We propose a system to up-cycle discarded plastic objects, visualised in Figure 5. This process consists of different steps (visualised in orange), that must be planned and sequenced:

1. collection of material
2. sorting
3. cleaning
4. shredding
5. melting
6. moulding
7. cooling
8. controlling
9. finishing
10. assembly
11. packaging/exhibition
12. distribution

The sequence is important and therefore needs a specific infrastructure. When designing this infrastructure, generalised and sequence-supportive dimensions were applied to create a flexible industrial structure within the project design.

Next to the sequence, the technical processes need planning and feedback loops, for which the dashboard provides directions. This manifests itself for example in sending push notifications when a certain storage unit is full.

Connected to the material up-cycling processes, there is also the opportunity to integrate a material library. This library has its own chain of redistribution, usage and re-collection. Both chains

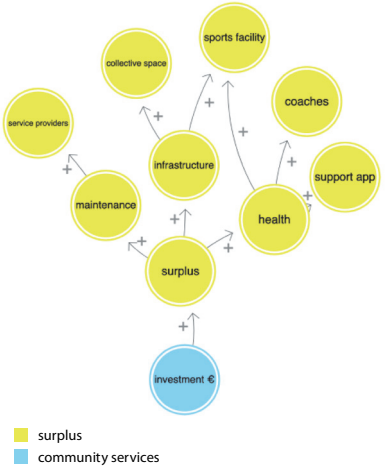
will need a real-time stock inventory, which must be transparent and consultable by all stakeholders.

Both project engines are connected to the dashboard to make this transparency and follow-up possible. These dashboard components are introduced as purple parameters within all Loopy diagrams.

Using Loopy as a tool, the diagrams can be used interactively. By applying each starting conditions, one by one, we are able to observe the effect of these factors on the whole system. Expanding the system, for example by dividing the investments equally over several functions, will ask for an expansion of the infrastructure. By taking such factors into account, the ability occurs to make these architectural zones adaptable in terms of height and volume, for example.

At this point the *surplus* part of the diagram also becomes important. In this phase, the extra value created within the system can flow into improvement, which shows in Figure 7. Because of the fact that none of the profit is extractable, this can only be re-invested within the community, which will cause growth and possibilities for the whole site and its users.

Figure 7
Surplus part Loopy diagram



Architectural Design

The existing structure of the project covers 6200 m^2 of footprint, enabling a program that could accommodate spatial necessities for the principles of urban farming (970m^2) and up-cycling (750m^2). An important aspect of the design is that the existing steel structure remains intact and visible. What's new, or added, must be reusable, in a way that the elements can later on be part of an easy up-cycling process. This for example results in a façade that is designed out of a frame, combined with panels. These panels can be different, already upcycled elements, as long as they fit onto the frame. Function-wise, the building operates as a dual engine. On one hand, public functions such as a coffee bar, social hub and nursery are serving the community and neighbourhood. Next to being useful, these functions must be located in a way that they stimulate social interaction.

On the other hand, up-cycling and urban farming principles can be applied within this building, in order to create a circular economy. Ranging from a material library, including a specific toy department, to a community-scale up cycling factory, used materials are essential within the productivity of the project.

DISCUSSION

The success of the existing Blikfabriek suggests that people in the area are willing to cooperate. Making an easily accessible tool for them to use this way of living and trading to a more organized version, asks for a design approach that goes beyond spatial design.

The dashboard helped with different features, for example the possibility to provide a tool inventory to share objects. This makes it relevant to design well-dimensioned and goal oriented, collective storage for these objects and minimise private storage space. The data-driven tools within the dashboard allow architects and other stakeholders to use specific number-based

Figure 8
Full Loopy diagram

information. This database is a source for detailed project research, while the Material market for example can be a source to build a new on-site project. This way, the dashboard can be used to generate large-scale solutions in different time spans. An example is the added structure of the project, which consists of remaining elements from another former structure on site. With the Material market, these ideas can be turned into actions really easily.

The systematic re-evaluation of the flow diagrams helped the dimensioning of the spaces. These spaces must be capable to accommodate an upscaled production capacity. By careful design of an economic system, the system can be optimised. This optimisation goes parallel with the design of the infrastructure, where the flow diagrams helped in a way that they organise the architecture. This organisation is from a crucial importance, because here form follows function.

The dashboard makes ideas possible in a sense that it helps logistically. Circularity is a popular word that still often stays within an idea phase, instead of moving to actual execution phase. The dashboard makes a circular design approach accessible and feasible, in a way that individuals of the community can easily take the initiative, what answers the first research question.

However, it does not stay on its own. The flow diagrams visualise the engines of the project and thereby provide the dashboard of data. We therefore conclude, to answer the first research question, that the parallel approach is a must, because each part of the triangle depends on the other ones. The dashboard could not have been designed without carefully mapping the economic and community flows in Loopy, as can be seen in Figure 8. To create a circular architectural design approach, all three methods belong together.

The flow diagrams could alter in functions though, what means that they can employ different engines than urban farming or up-cycling, depending on the community's needs and (spatial) opportunities.

In general, the proposed circular architectural design approach makes it possible to design a coherent and possibly self-sustainable environment. Next to that, it also opens gates towards designing phase per phase, on long term. Because of the built-in income engines, the community has investment possibilities within certain timeframes.

A constraint however, is the fact that this circular architectural design approach has not been validated by the community. Future research is necessary, for example gathering feedback from Blikfabriek members and collecting survey data within the neighbourhood.

CONCLUSIONS

From an economic and environmental point of view, neighbourhoods and cities benefit from a circular architectural design approach. Creating an actual circular economy and community, asks for more organisation than purely spatial design. By extending the design activities to a decentralised dashboard and mapping economic and community flows of the system, we step away from the linear design approach. Doing this, architects and other designers are able to develop strategies to determine the lifecycle of a building, far after the delivery date.

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