REDEFINING THE PERI-URBAN INTERFACE OF THE DUTCH CITY OF ASSEN THROUGH REGENERATIVE SELF-BUILDING

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ABSTRACT

This project explores the problems of a lack of housing in the Netherlands, the inevitable city expansion in the future and the current linearity of the construction and agriculture industries. It aims to tackle housing needs through self-building and to establish a more nurturing and participatory connection between users and their environment through a regenerative approach to architecture. The vernacular building practices of the hallenhuis in Drenthe are translated into tangible knowledge regarding materials, connections and tools as to propose a technical framework for a self-build design. The study is guided by the main question: How can we translate the relationship of Vernacular Architecture in Drenthe with its landscape to applicable knowledge for regenerative self-building in the modern context? In three chapters, the socio-economic roles and tectonic relationship of the hallenhuis farm with their landscape, the opportunities and implications of a future regenerative production of building materials and the applicability of vernacular practices to modern self-building are discussed. The paper presents data on the geographical, material, economic, social and technical layers of the hallenhuis typology and its surroundings. The evident relation between a regenerative approach and self-build architecture is accompanied by the complexity of problems and opportunities regarding the implementation of a regenerative building material network. The conclusions indicate further research is desirable and could consist of comparative studies across regions, quantification of environmental impacts and expansion of the field scope to food production, urbanism or landscape design.

KEYWORDS: *regenerative architecture, self-building, vernacular, peri-urban interface, housing crisis, local building materials, agroforestry*

I. INTRODUCTION

The Netherlands faces a housing shortage of 900,000 new homes by 2040 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022a). Urban densification is the primary strategy, see figure 1a (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022b). However, city expansion or new settlements become inevitable due to eventual liveability concerns of densification (UN-HABITAT, 2017) and the ministry suggests 35 to 40 % of the housing plans will be built outside the existing built environment (De Jonge, 2022) which raises questions on what the peri-urban interface (PUI), the conceptual understanding where rural and urban land uses co-exist (Bouwyer-Bower, 2012), will look like (Avermaete & Schoonderbeek, 2010; McGregor et al., 2012).

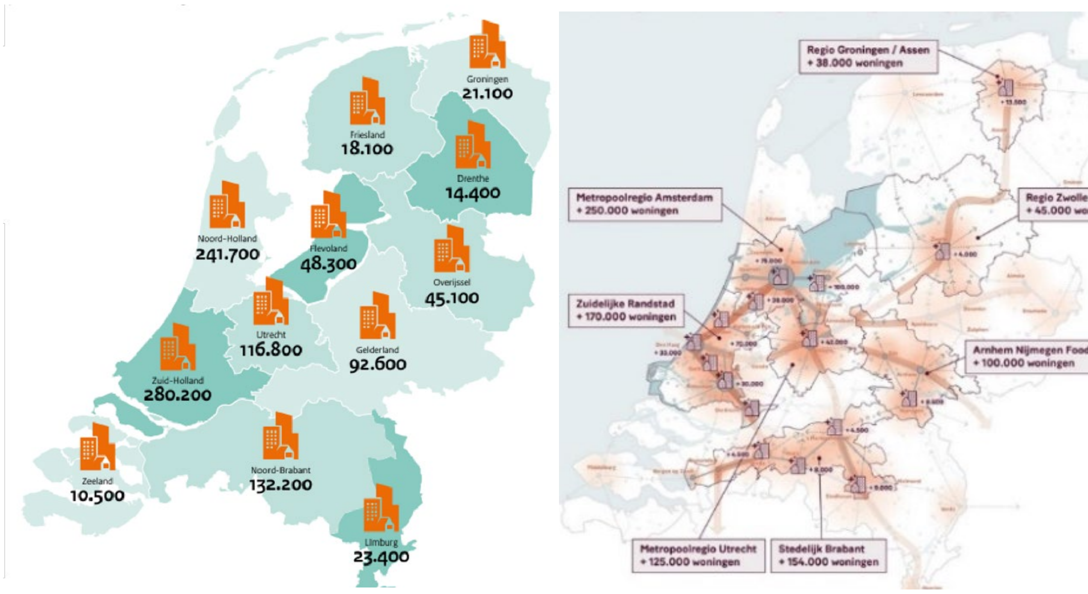


Figure 1a (left). Plan capacity housing before 2030. Reprinted from (Inventarisatie plancapaciteit najaar 2021 Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022b, p. 9)
Figure 1b (right): Housing need for the seven most urbanised areas in the Netherlands before 2040. Reprinted from (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021, fig. Woningbouwaantallen tot 2040).

The linear construction and agriculture sectors contribute to global emissions, material depletion (*Sand Wars*, 2014), biodiversity loss (Rafferty, 2024) and a decrease in project sustainability (Kushnir, 2020). These industries also cause high levels of ammonia and nitrogen oxides that threaten ecosystems and human health (Ministerie van Algemene Zaken, 2023). To address these issues, a shift beyond short-term thinking is imperative. Academics advocate for a *regenerative approach* in the design and planning industry (appendix 1) (Armstrong, 2023; Du Plessis, 2012; Hes & Du Plessis, 2014; Konietzko et al., 2023; Koreman, 2024; Littman, 2009; Lyle, 1994; Mang & Reed, 2013). The regenerative approach aims to halt natural system degeneration and foster coevolution with human system (Mang & Reed, 2013). The hypothesis posed by these academics is that if a regenerative approach is applied then the linearity of industries, such as construction or agriculture, dissolve and they become part of the natural system. It is notable that such an approach has overlapping qualities with *bioregionalism* and *critical regionalism*, both responses to a perceived homogenization and globalization of (architectural) practices. The architectural theorist Kenneth Frampton (2001) emphasizes the importance of the local context and environmental conditions and seeks a constant balance between the local and the universal, the traditional and the modern, whilst addressing social and cultural aspects of architecture. Frampton sees the role of craftmanship in construction and the relationship between engineering and architecture, the *tectonics*, as essential parts of architecture. He especially notices the how essential this notion is for *vernacular architecture*.

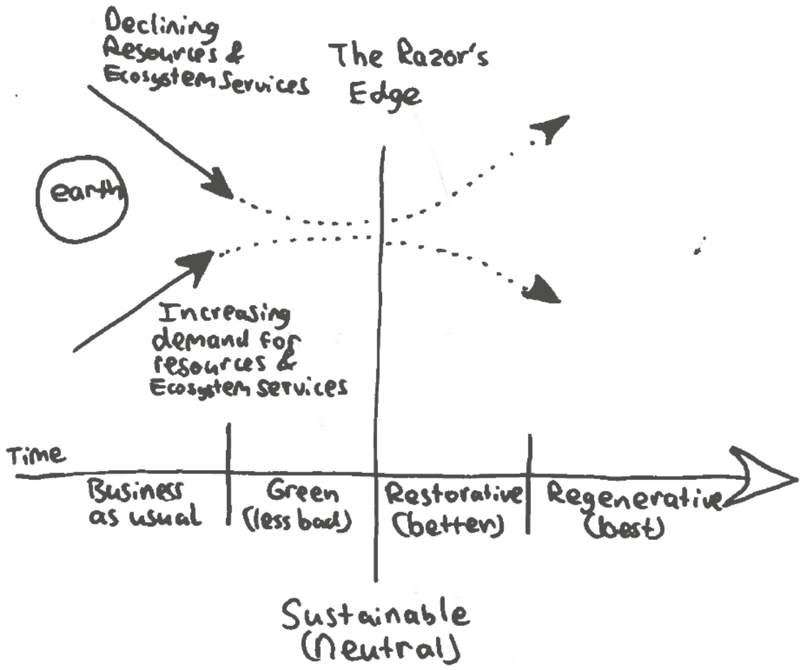


Figure 2. The natural step funnel. Adopted from (Fleming & Roberts, 2019, p. 79)

Besides the quantitative lack of housing Netherlands there is a shortage of qualitative diverse and adaptable homes (Delft University of Technology, 2024). A self-building revolution, such as induced by Walter Segal's Segal method in the 1960s, as part of the solution would lead to less inequality on the housing market, diverse and customisable housing and more participation and sense of belonging (Grahame et al., 2017; Maarhuis, 2023; McKean & Segal, 1989). As a rule, the nature of this building method invites an active and concerned attitude of users. There is however a lack of knowledge and understanding of the role that users can play in the building phase of their home. Knowledge that, in the Netherlands too, was widespread and passed on through generations of builders before the industrialisation of the building industry took over this network. Costs, unclarity, lack of freedom of choice and not knowing the first steps of making homes more sustainable are additional barriers for the Dutch to live more sustainably (Koolen, 2022). These gaps call for updated knowledge on building processes for renewable local materials, knowledge of vernacular craftmanship and practices that has faded to the background in modern building industry.
The combination of recent issues concerning housing development versus a call for the conservation of diverse ecosystems (Benak, 2023), the prospect of Drenthe being next in line for future housing projects according to Chief Government Architect Francesco Veenstra (Naaktgeboren, 2024), the discussion on the peri-urban and architectural edge conditions, an existing incentive for self-building (Guit, 2024; RTV Drenthe, 2023) and a need for small households makes the Dutch province of Drenthe an excellent case study for further exploration of the problems discussed.

Self-building in the Netherlands is no innovative practice and for centuries Dutch families built their own farms from local materials. Therefore this paper intends to answer the following question: How can we translate the relationship of Vernacular Architecture in Drenthe with its landscape to applicable knowledge for regenerative self-building in the modern context? If the conditions of the pre-industrialization era ensured a stronger local connection with the landscape resulting in its tectonics then self-build architecture can incorporate knowledge from past practices into a regenerative approach.

II. METHOD

The aim of the research is to apply the understanding of the interrelation of vernacular practices with the landscape and local craftmanship to self-building in the modern context. The results are arranged in three chapters as response to the following sub questions:

Hallenhuis and landscape

1. What role did vernacular hallenhuis farms and the farmyards play in the social-economical context of Drenthe?
2. What was the relationship between the tectonics of vernacular hallenhuis farms in Drenthe and their surrounding landscape?

Implementation of regenerative building in Drenthe

3. What are the opportunities and implications of introducing production strategies in the ecosystem to meet the demand for regenerative building materials?

Applicability of the vernacular knowledge of the hallenhuis to self-building

4. How can the opportunities and potential barriers of the vernacular architecture of farms in Drenthe inspire modern regenerative self-building techniques?

The first chapter consists of a case study on the hallenhuis on Asserstraat 78 in Zuidvelde, Drenthe. To comprehend the interrelation with the landscape, the function and farmyard elements, the tectonics and the origin of building materials of the vernacular example are analyzed and compared to a mapping of the ecosystems related to the farm. This chapter is based on literature, maps, fieldwork in Zuidvelde and archival research of the Drents Archief (Drents Archief, Assen. Toegang 0955 Tekeningen Provinciale monumentenzorg) and the Groninger Archieven (Regionaal Historisch Centrum Groninger Archieven (NL-GnGRA), toegangsnummer 2452, Prof. Dr. A. Blaauw (2), 1908 – 2007). In the second chapter the implementation of growing regenerative building materials in the modern context is evaluated according to a SWOT analysis to map the implications and opportunities of introducing a regenerative production chain. The topics that will be assessed are based on the Doughnut of social and planetary boundaries model by Kate Raworth (2012). Both vernacular materials from the case study and other state of the art regenerative materials are assessed with data from interviews with employees of Staatsbosbeheer and state of the art literature. The third chapter presents a SWOT analysis on the applicability of technical results from the case study to modern self-building practices, based on a case study comparing the self-build method of Walter Segal to the results of the hallenhuis analysis.

III. HALLENHUIS AND LANDSCAPE

3.1 Landscapes and Farming in Drenthe

Farming in Drenthe closely relates to the underlaying geographical conditions caused by the meltwater landscape and the soil types. The melting water of the last ice age resulted in a plateau of *keileem* [boulder clay] covered with *dekzand* [cover sand]. The ridges and channels became the sandy hills and the stream valleys, a contrast of high dry grounds and lower wet conditions, see figure 3 (Berben, 2022; Gemeente Midden-Drenthe et al., 2022; C. Joziasse, personal communication, 5 June 2024; Kleijn, 1984; TNO-GDN, 2024). Over time, the barren lands developed into heathlands and marshes arose as the climate got warmer (Gemeente Midden-Drenthe et al., 2022). Drenthe was one of the first areas in the Netherlands with settlements and early forms of agriculture (*celtic fields*) where the landscape was altered by reclamation since 1200 BC (Kleijn, 1984).

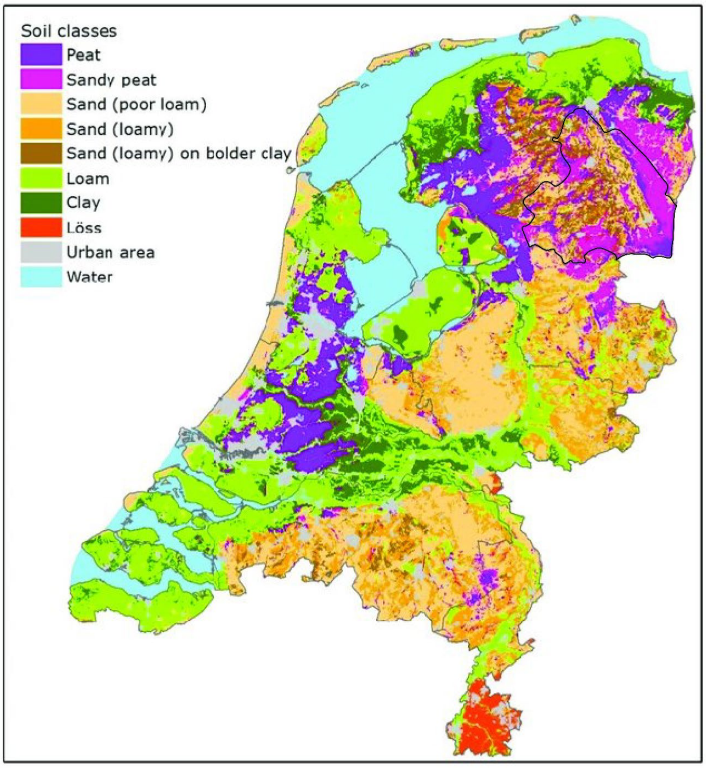


Figure 3 . Soil types in the Netherlands. Reprinted from (Van Den Berg et al., 2017)

Around 700 AC the *esdorpen* [domed land], the first permanent settlements in Drenthe, positioned themselves high up on the ridges (Hondsrug) to prevent their *essen* [elongated fields] from flooding. For the grasslands located in the stream valleys, this was less damaging. The villagers kept sheep that grazed the heathlands and returned to the close communities at night, where the manure was collected in the *potstal* [deep litter] to improve yields on the field. The grasslands supplied hay for the winter (Kleijn, 1984; Nationaal Park Drentsche Aa et al., 2023). The agricultural quaternity system, consisting of the esdorp, stream valley, heathland and the es, obeyed the rules and natural boundaries set by the conditions of the landscape (figure 4). The farm played a key role in this system as a base from which the adaptation and cultivation of land operated, as well as a mediator between different material flows and processes.

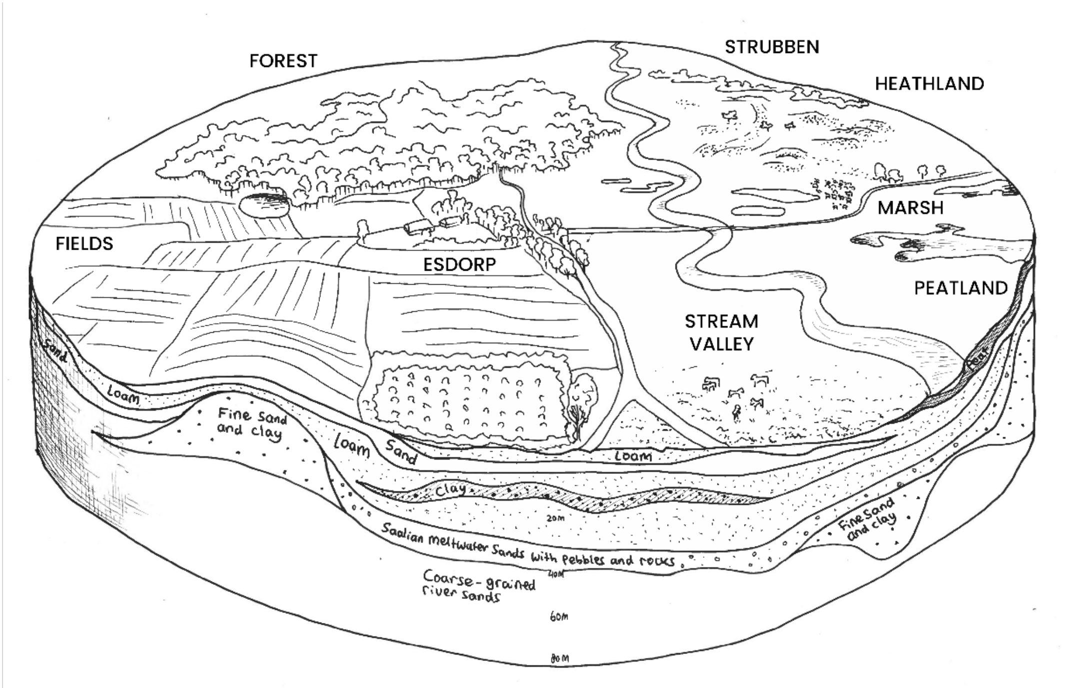


Figure 4. Representation of the geomorphology, cultural landscape and soil types of Drenthe. Created based on (Gemeente Midden-Drenthe et al., 2022; Glimmerveen, 2022; TNO-GDN, 2024; Van Den Berg et al., 2017).

The allotment of the *markelanden* [common lands] from the late dark ages into the 19th century, driven by a longing for individual property, had a big impact on social, economic and ecological aspects of the landscape. The emergence of artificial fertilizers (around 1900) and peat mining accelerated the allotment as sheep manure and heath sods became obsolete and heathlands were mined and replaced by production forests and additional agricultural fields. Changes in farming practices directly affected the cultivated landscape but were also reflected in the village character. Mechanisation led to different criteria for the architecture of farm buildings and peat mining even resulted in the new *streekdorp* [regional village] village typology (figure 5) (Kleijn, 1984).

The business of farms in Drenthe fluctuated. From cattle farming (1600) to sheep and rye (1700) to cattle again (1900). The majority of the field yields fed the livestock. The fluctuations in the farming business shows in the division of essen and in the changing spatial streekdorp plan of farms and their surroundings (Kleijn, 1984). The *marke*, consisted of grasslands, heathland and forests for building materials and fuel. The *brink* [village green] (figure 6), a triangular grassland in the village contained a reserve of oak trees for construction or repairs. Oak trees along the farmyard roads had the same function (C. Joziasse, personal communication, 5 June 2024; Kleijn, 1984; Muffels, 2005). Late 19th century wood use shifted to poplar as oak grew too slow. Other elements on the farmyard included the *zoddenschuur* [sod shed] (fuel storage), Bentheimer wells, oak fences, the *stookhut* [boiler house] (cooking food for livestock and baking) (Jans et al., 1980; Muffels, 2005). Notable observations are the combination of personal and collective ownership and storage of building materials, as well as the functional spatial allocation of farmyard elements to specific functions within the farming business.

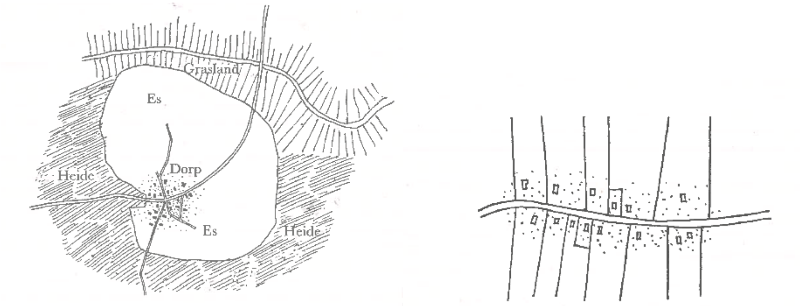


Figure 5. Layout of an Esdorp (left) and a Streekdorp (right). Reprinted from (Jans et al., 1980, p. 18)

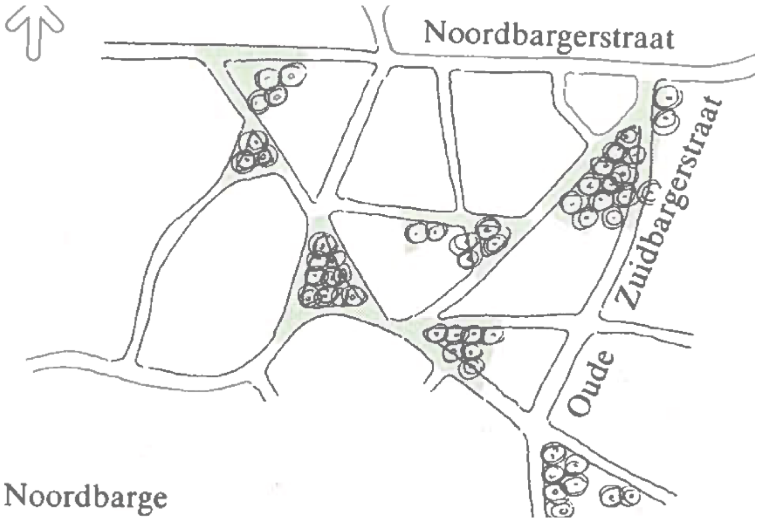


Figure 6. Analysis of the Brinken in Noordbarge, Drenthe. Reprinted from (Kleijn, 1984, p. 117).

3.2 Analysis of the Hallenhuis

A *hallenhuis* [Aisled hall house] is a Dutch farm typology that developed in the dark ages from the *lös huus* [open house]. Characteristics are a thatched roof supported by anchor beam trusses and a three-aisled design with a wide central *deel* [working/treshing floor] wedged between two narrow side aisles (Jans et al., 1980). The living area in the front is separated from the working area. Further organisation of spaces is shaped by functions derived from farming practices (*Geheugen van Drenthe*, n.d.; Van Olst, 1991). The need for more storage space, availability of materials, structural and logistic considerations led to variations in the floorplan (placement part doors, working floor program) and roof design, see figure 7. The changing farming industry and well-being requirements regarding daylight and hygiene additionally influenced the tectonics of the farm. Interestingly enough, the logistic decision to locate the part doors near the road ignored climatic considerations and sun orientation, a peculiar choice in vernacular architecture (Frampton, 2001; Jans et al., 1980; Van Lengen, 2008).

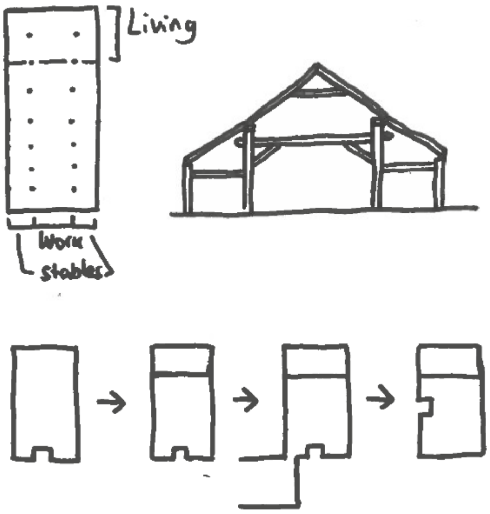


Figure 7. Analysis of main design and transition of the different typologies over time. Created using information from (Blaauw, 1983; Jans et al., 1980; Kleijn, 1984; Provinciale monumentenzorg, 1957a, 1957b, 1969)

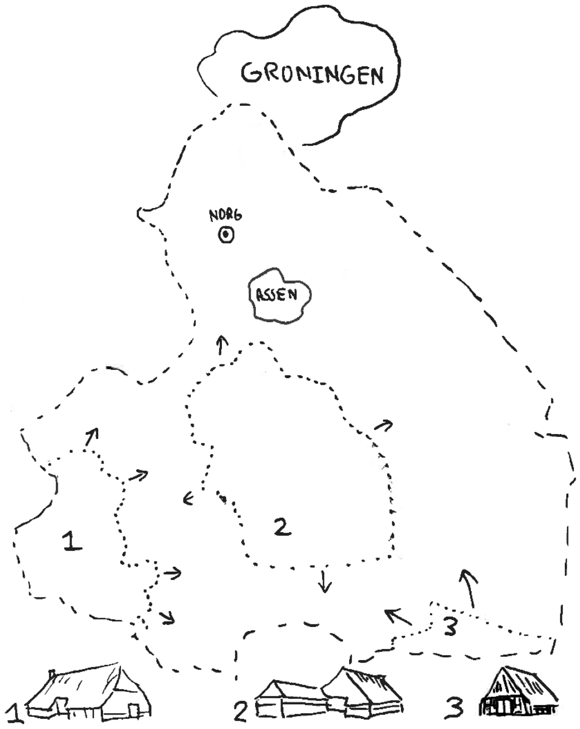


Figure 8. Spread of hallenhuis typologies. Adopted from (Jans et al., 1980).

The esdorp Zuidvelde remarkably exhibits a range of these main typologies: *middenlangsdeeltype* [working-floor-along-the-middle type], *dwarsdeeltype* [working-floor-across type], the *overganstype* [transition type] and variations of the *Friese groep* [Frysian farm group] (Jans et al., 1980; Stenvert, 2001).

A tectonic approach to analysis of vernacular farms is indispensable as they were not designed in that sense, but were rather physical reflections of the working life of farmers in the Netherlands. Its construction method was arguably more important than the architectural ideas of the local communities. The tectonics of the hallenhuis is dominated by the presence of the anchor beam truss, see figure 9. The oak wood supporting structure allows for bigger spans and larger storage space in the thatched roof with efficient use of materials compared to the simpler *langsbalkgebint* [longitudinal beam frame] The storage space in the roof was a by-construction-defined economic boundary. The anchor beam trusses further dictated the tripartite division along the whole farm. Additionally, the wooden trusses facilitated non-load bearing infill of exterior walls, first with willow wickerwork and loam succeed by brick walls.

The flexibility of the floorplan and adaptability of the supporting structure that the wooden-peg-and-hole joints offered, were gratefully used when farming practices changed and when the working section was later on transformed into farmhouses. Re-use of structural wood was common and indicates efficient material use (Kleijn, 1984; Van der Waard, 1996). The steep textured roofing for weather protection, consisting first of local materials (straw and heath sods) and later of imported reed and ceramic rooftiles, reflects its use as storage space and determined the townscapes. Availability, proximity, costs and processing possibilities of raw materials determined which materials were used. It could be stated that in these vernacular farms form followed function and true material honesty was maintained.

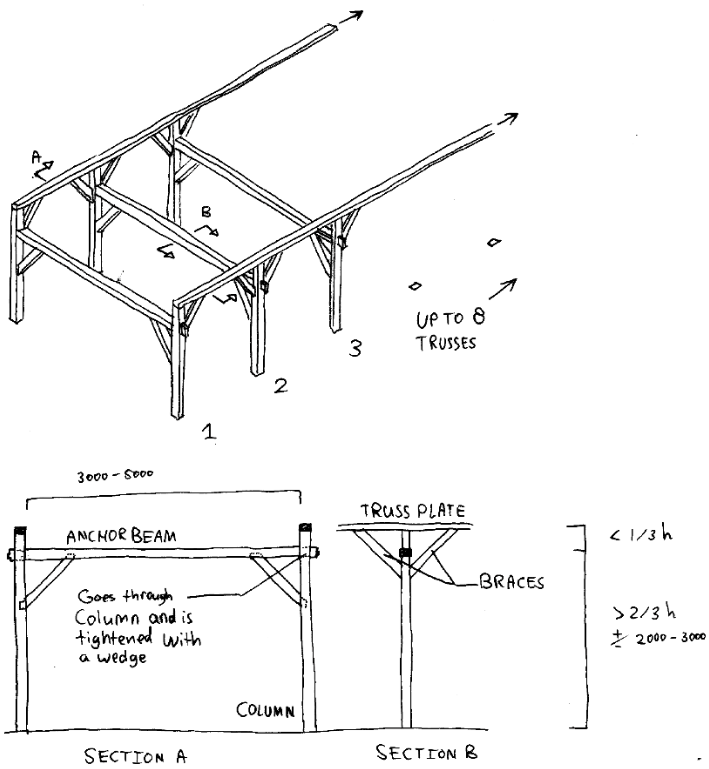


Figure 9. Anchor beam truss principle. Own work.

Specialised preparation of building components in the building process were performed by the local carpenter and the roofing was done by the thatcher. Both crafts used several types of hand tools such as *naald en goot* [needle and gutter] for thatching the roof. The rest of the village helped the owners with the building phase and physically demanding labour of lifting the trusses was done in collaboration, see figure 10. Holes in the trusses facilitated lifting the trusses with the help of a *kanthaak* [hook] (Van der Waard, 1996). Generally, the craftsmen had side jobs since scarcity of jobs or the seasonal conditions did not allow the work to continue (Van Der Zandt, 2017). This combination of specialism and unskilled forces was the key to success in the farming context.

The applied local building materials of the hallenhuis are spread over all three traditional categories of raw materials, earth, wood and fibre, as presented in the report *Naar een Nieuwe Streekarchitectuur* (Smit et al., 2022). The main supporting structure was erected in oak wood, resting on a foundation of field boulders or a brick base (Kleijn, 1984). Throughout time, scarcity of oak led to other wood use such as pine or poplar (secondary structure) (Jehee, 1996). Wood came from production forests or the farmyard (C. Joziasse, personal communication, 5 June 2024; Natuurmonumenten, n.d.; Strootman Landschapsarchitecten & NovioConsult Van Spaendonck, 2008; Tillema, personal communication, 5 June 2024). Wood finishing was made from several types of local trees such as oak, pine, beech, birch, maple, walnut, poplar and elm (Jans et al., 1980; Kleijn, 1984). Willow branches, used in the wickerwork and roof thatching, and reed were mined from the wetlands of for example the Onlanden (Stichting Natuurbelang De Onlanden, n.d.). Straw and heath sods were taken from the local grasslands and heathlands. *Potklei* [peat clay] for rooftiles and bricks was mined in the north of Drenthe or baked bricks from alluvial clay were imported from the bigger rivers in the Netherlands (Berben, 2022).

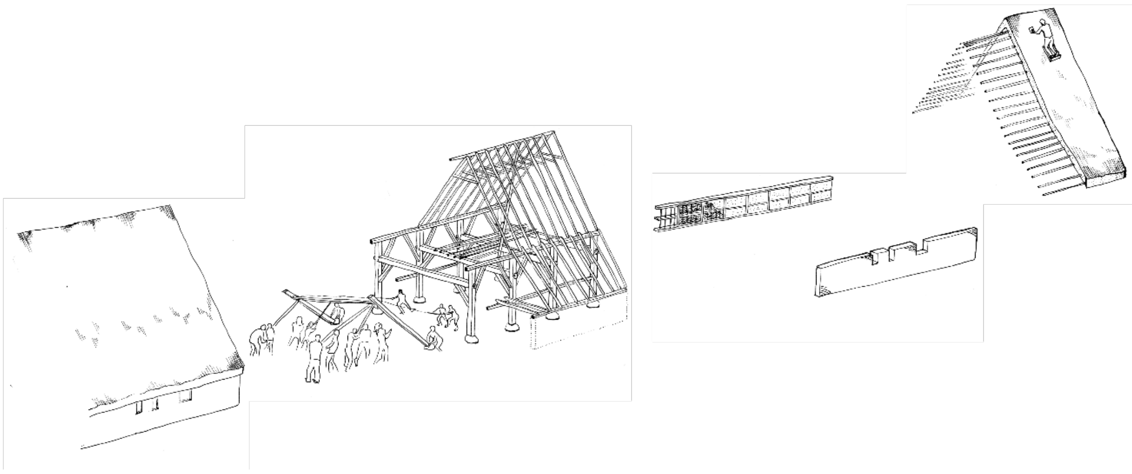


Figure 10. Building method of the hallenhuis from left to right: finished farm, anchor beam trusses and secondary roof structure, self-bearing wickerwork or brick walls and thatching of the roof. Own work.

3.3 Landscape and materials

Although the import of building materials in Drenthe increased with the improvement of infrastructure, the layout of farmyards and communal lands for growing building materials remained. Besides the complete transition from wickerwork loam walls to brick walls and the partial exchange of reed thatching for ceramic rooftiles, locality of building materials was preferred. This mindset is somewhat to be expected from a vernacular building practice whose farming business is too, based on self-sufficiency (Van Lengen, 2008). Where local production could not satisfy the demand, materials were imported from nearby regions (Kleijn, 1984).

IV. IMPLEMENTATION OF REGENERATIVE BUILDING IN DRENTHE

4.1 Reflection on SWOT Analysis

The results from chapter 3, together with interviews with employees of Staatsbosbeheer and state of the art research will be discussed in the following chapter where an increase in the use of regenerative building materials in the modern context is evaluated. The strengths (S), weaknesses (W), opportunities (O) and threats (T) of introducing production of regenerative building materials in the ecosystem of Drenthe, see appendix 3, can be discussed from the environmental, social, economic and technical perspectives.

The availability of a variety of resources and the prospect for upcycling waste streams and harvesting invasive species, an historic record of vernacular use of these materials and potential for integrating regenerative forestry into existing policies and plans are all promising environmental and economical indications for a regenerative building material economy. It is important to make changes in both short and- long term planning. Transition of agricultural land to multifunctional forestry and crop fields are thought to be a good replacement of the vulnerable conditions the existing forests face now. It is essential to consider mining methods and machinery that cause minimal damage to soil life and habitats. Planting trees on agricultural land fits the governments agenda and provides richer growing conditions, especially benefitting non-native pine trees, and improves the poor soil quality. To ensure a numerous future timber stock, diversifying and adapting management in current forests and an investment in new regenerative forestry is needed. Starting with harvesting current trees that cannot handle their surrounding conditions, such as the pine in sandy soils, or trees that are affected by pests can also diversify existing forests. Where sick, or misplaced trees are harvested, a variety of new native species with different life durations can be planted which increases biodiversity and puts trees in the growing conditions for optimal growth. These changes can be linked to the plans of the government to increase Dutch forest land with 40.000 hectares (C. Joziasse, personal communication, 5 June 2024). The shrinking agricultural land inventory (because of nitrogen, vegetarianism and predicted increasing efficiency in agriculture) could offer the missing medium of exchange for the, somewhat ungrounded, government plans while at the same time producing diverse wood production in 60 years. When trees are integrated in the agricultural fields (agroforestry) it is important to balance the division of light, water and nutrients.

Fibrous crops such as hemp, flax, elephant grass and bulrush can be other regenerative sources for building materials, but monocultures should be limited to ensure a healthy biomass production that entails facilitating biodiversity and good abiotic conditions in the future. Non-regenerative materials or processing and treatment that harms the environment (subsidence peat mining) or our health pose threats to the environment and are to be limited in use. Earthen materials (clay, sand, loam, minerals) are not truly regenerative and therefore demand limited use and minimal (irreversible) treatment is preferred. The environmental impact of suggested proposals need further consideration backed up with data, for example the choice between wool production and low maintenance of heathlands with the methane production of sheep.

Where local production increases awareness and collective responsibility, the transition from agriculture to agroforestry demands flexibility of farmers and governments as they need to shift their farming practices and resources and enter the market for building materials as a new competitor (Bouwboeren, 2021). Policy on preservation and maintenance of protected areas currently do not allow mining or upscaling material production and thus secluding mining peat clay, for example. There are waste streams however that are not optimally benefitted as of now. Upcycling these waste streams (natural grass, pruning cuttings and wool) and use utilisation of byproducts of mining practices (pebbles and field boulders in loam and clay) can add to vernacular and existing building material supplies. Also, the (on average) shorter lifespans of regenerative building materials demand more maintenance. Therefore integration of repairing and maintenance strategies in the product cycles is important.

Technical opportunities encompass optimal use of material and composites properties (hempcrete, light clay), improved vernacular technologies (insulated closed reed roof with ventilated cavity) and newer building components and methods (strawbale construction, hempcrete). Engineered wood and Solid Laminate Timber Systems (such as) cross-laminated timber (CLT) have great potential, although glue binding layers and proximity of the manufacturing process influence its applicability in a bioregional production system.

V. Applicability of the Vernacular Knowledge of the Hallenhuis to Self-building Practices

5.1 The Segal method

German architect Walter Segal's method for temporary homes is an example of architecture for self-builders. The idea that components would be minimally altered to be sold later emphasized the temporal connections. A modular system of standardized lightweight (timber) materials, a strict grid size and bolted connections allow users to change, extend and easily repair their homes. Segal's goal was to provide users with a toolbox, consisting of steps and a building order to follow, to build their own home. His practical and economical approach served the speed and convenience of the building process. Dimensions were standardized and calculations simplified (Cooney, 2015; Grahame et al., 2017; McKean & Segal, 1989). Segal's pragmatic way of thinking extended into the steps in the building process and order, which he perfected over the years, see appendix 4 and figure 11.

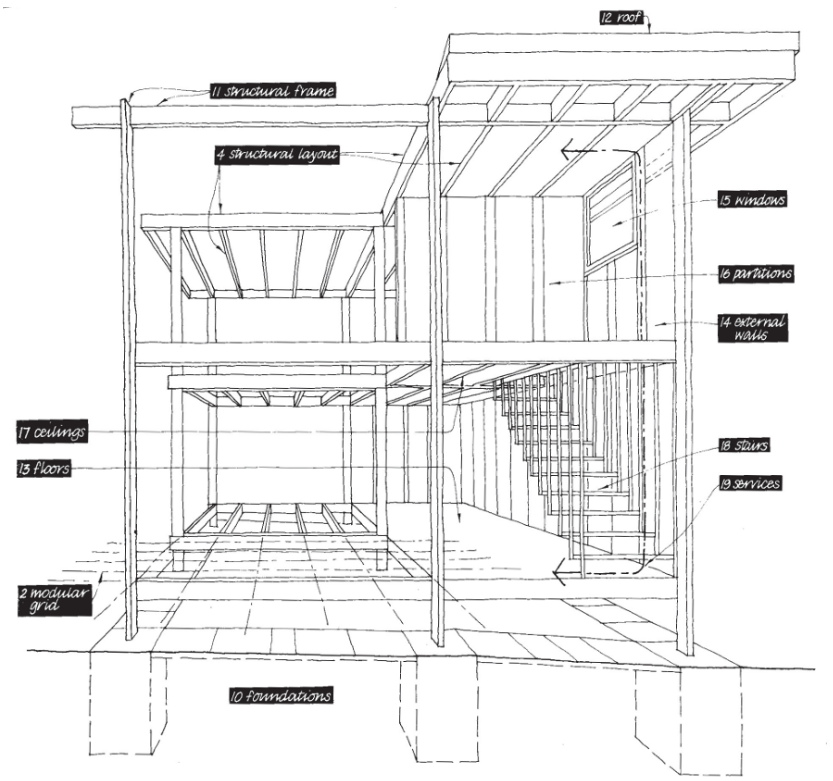
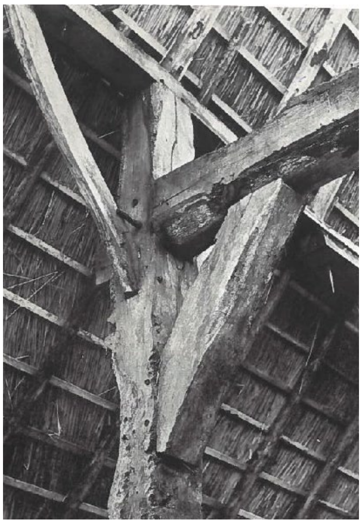


Figure 11. Principles of the Walter Segal Method. Reprinted from (Cooney, 2015).

5.2 Comparison Segal and Hallenhuis

Segal's goal to give self-builders the means to build their home was not necessary for farm owners wanting to build their own hallenhuis, more than a century before Segal's existence. The craftmanship and knowledge of the hallenhuis was still tangled in tradition and collective memory (chapter 3). When further comparing the case studies, a few interesting differences can be distinguished. Where the standard three dimensional orthogonal grid of Segal allowed extension in all directions, the tripartite division grid of the hallenhuis facilitated extension in one direction. Segal's pragmaticism brought him to a standardisation of structural elements to fine tune with the existing lumber market, while the whimsical shapes of the oaken posts of the hallenhuis are clear reminders of the natural irregularities of grown material. Another important difference is the lightweight timber frame of Segal, compared to the heavy oak frame of the hallenhuis. Both used dry connections, but although wooden-peg-and-hole joints of the farm simplified reuse of structural elements, demount ability was of less importance than for Segal's dry-bolted connections, see figure 12a and 12b (Cooney, 2015; Grahame et al., 2017; McKean & Segal, 1989).



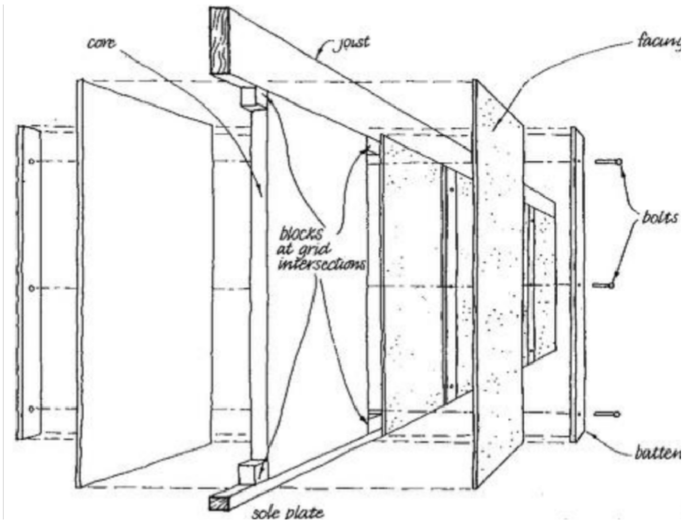


Figure 12a (left). Anchor beam truss connection. Reprinted from (Jans et al., 1980, p. 57).
Figure 12b (right. Exploded axonometry Walter Segal system. Reprinted from (In Future Wood, 2019).

5.3 SWOT Results of Translation Hallenhuis to Self-building

The Results from the case study on the hallenhuis pose several opportunities for modern self-building, see appendix 5. Local mining and processing of building materials encourages the local economy, strengthens the communal self-reliance and relates to the critical regionalism principle of contextualism. However, they need the approval of government regulations and missing regenerative materials chains must be completed. Furthermore, the usage of material flows can be optimised. Life spans of wood can be extended through cascading (Fraanje, 1997) or through reusing timber structures, as was done in the hallenhuis. If spans of the supporting structure are kept to a minimal and the wood does not show too many irregularities, the thinning wood of oaks older than 30 years can already be used for small lumber (Fraanje, 1999). The traditional mortise-and-tenon joints of the hallenhuis can be simplified and possibly combined with bolted connections to decrease labour and necessity for machinery. These skills can then be passed on by the self-building community to be rooted in society once more.

The comparison of the hallenhuis case study with the Segal Method offers further reflections on the translation of vernacular knowledge to self-build architecture. Segal's aim for convenience, speed and demount ability yielded a modular building system. Perks that relate to future self-

building with regenerative materials are greater flexibility in the floorplan and supporting structure, easy replacement or repair of components and simplification of building steps and calculations. However, standardisation and a strict grid size and thus standardised tectonics, do not stroke with critical regionalism (Frampton, 2001).
Tasks that need contractors (specialised skills, knowledge or machinery), such as roof thatching, should be identified in the planning phase to ensure an optimal workflow for self-build homes. The balance between work that can be done by self-builders or for which contractors are needed depends on available materials, complexity of the chosen construction method and details, budget and the skill level and labour commitment of the self-builder. Aligning these factors, seasonal influences and drying-setting time with the hierarchy in the building order will enable clear instructions and prevent unnecessary delays. It seems that the simpler and more low-tech the building method, the more evident the community engagement (present in both analysed cases) and the more grounded the self-build project in its local context.

VI. CONCLUSIONS

The results from the research are qualitative and collected in a wide scope of academic and hobbyist fields (cultural and environmental history, vernacular architecture studies, anthropology and geomorphology) through readings, maps and drawings. These findings, more often than not, were not part of the main argument within these sources. The results reveal how complex and multidisciplinary vernacular studies are, especially when projected onto possible future developments. This complexity may come as no surprise to those who have indulged in the academics of holistic design and regenerative approaches. This research attempts to comprehend the narratives of past conditions and practices and, within the restriction of the limited resources and time, derive conclusions for future recommendations for self-builders that want to operate within a regenerative vision.

In the historically agricultural-oriented province Drenthe, the farm was the centrepiece in the quaternity of the farming business model (esdorp, stream valley, heathland and es). The hallenhuis was where products were processed and stored. It was the, so to say, headquarters of the agricultural business of the cultural landscape from where the lands and workers were managed, while also remaining the home of the owners. In this metaphor the farmyard, with its functional layout harbouring storage space for agricultural products and building materials, is the industrial estate.

The relationship between the architecture of vernacular farms in Drenthe and their surrounding landscape can be best described through a layered analysis approach. The case study shows this layering consists of geographical conditions, soil type, water bodies, abiotic conditions, vegetation, cultural intervention, ecosystem services, social and economic system and finally community engagement and ownership. Each layer building on top of one another. The materials of the farms, for example the oak wood for anchor beams, depended on local vegetation, which depended on abiotic conditions, soil type and thus underlying geographical conditions. The somewhat limited choice of materials derived from the availability in direct surroundings (although altered) and expanded as the suppling network of materials grew (improved transportation, new building products, centralized production). The architectural language of the hallenhuis is an example of being true to the knowledge (skills, processing) and resources (labour, tools) at hand. Its tectonics developed alongside the functional and technical changes of the 20th century without being completely disregarded as a typology of its own. Although the hallenhuis has mostly lost its position as a functional business hub, it is quite remarkable for the *esdorpenlandschap* to remain as evidently visible to this day in an environment of rapid change and optimization.

The agricultural system complied with the fluctuations of seasons and the natural conditions set by the landscape. It is therefore tempting to romanticise vernacular practices and state that farms in Drenthe had a *mutualistic* relationship with nature and its cultural landscape, but the results suggest a more nuanced reality. It is true that farms were built with local materials, with traditional methods and by local people, but their agricultural practices of land preparation, mining and burning heathlands harmed the natural system and barely align with regenerative principles and believes. Where the landscape was not harmed by human intervention (heathlands, grasslands), the vernacular hallenhuis and the surrounding practices had a relationship of *commensalism*. In other areas they were in *competition* with one another. The relationship was more based on practicality. Planting oak as building material stock on farmyards and communal lands and mining small amounts of heath for it to regrow were examples of practical long term planning strategies. The practical approach further shows in the division of land, in the layout of farmyards and hallenhuis floorplans, reflecting the working life.

Artificial fertilizers, mechanization and planting large scale monoculture forestry continued and started to shift the relationship towards something more comparable to *parasitism*. Inspiration can primarily be taken from practical solutions that, somewhat coincidently, coincided with regenerative principles to shape a future that tends more towards a mutualist relationship between the farm and the landscape.

The evaluation on the opportunities and implications of producing regenerative building materials in the modern context case has shown that the locality of vernacular farms in Drenthe is a good starting point for such a system. Today's challenges (higher land use, biodiversity loss, decreasing soil and water quality and high nitrogen levels) demand multifunctional solutions. Further hurdles are higher standards in the building industry, loss of knowledge and the need for old supply chains to be restarted and adapted to the current context. The business opportunities for farmers, health and maintenance requirements are further factors to be taken into account. Technological optimisation of materials and innovation do have a place in the regenerative building materials industry, but a balance between prefabrication and low-tech that does not compromise the principles of the regenerative approach is desirable.

In the bioregional approach and Frampton's (2001) theories on tectonic, the importance of the context is emphasized. Part of this key aspect is the availability of materials as well as the production chain and craftmanship surrounding the (vernacular) building practices. The hallenhuis farm teaches us a number of things applicable to regenerative self-build approaches. Firstly, the reuse of structural elements as performed in the hallenhuis and timber cascading extend the lifetime of materials, minimising the pressure on forestry and frequency of harvesting. Using thinning wood in the future, as high up in the cascade as possible, maximises the potential of the raw material and aligns with regenerative forestry management. Secondly, the anchor beam trusses can be an inspiration for a timber structure allowing flexibility in the floorplan. Rather than taking a strict modular system (such as that of Segal) as a base that tends to result in uniform architecture, the adaptability of a self-build home can revolve around the separation of building layers (also benefitting repair and maintenance) and the expandability of timber structure in several directions. Thirdly, for self-build regenerative building in Drenthe a solution is desired where the structural qualities (stability, large spans) of anchor beam trusses meet the speed, simplicity and light weight of Segal's method. Such a trade-off might entail settling for smaller spans or using timber composites (I-joists, box beams) (Cramer, 2023). Such light-weight structural elements allow self-builders to lift and built the structure on-site. Furthermore, the traditional mortise-and-tenon joints can be simplified and improved with non-glued solid laminate timber systems (NLT, DLT and interlocking CLT) and complemented with other mechanical connections if necessary. Simple and low-tech building methods and details increase the potential for self-build usage. The hallenhuis and the Segal Method also highlight the importance of the task division and clear planning for an optimal workflow and to answer the questions who will do what, when and how?

Reflecting on the layered analysis of the hallenhuis and connecting this to an example of a self-building method, a parallel can be drawn between past building practices and possible future applications. Just like the vernacular farms in Drenthe needed the right abiotic and biotic conditions as a base, modern regenerative self-building in Drenthe requires healthy local vegetation and the underlying processes to foster sustainable relationship with the surrounding landscape. In the historic cultural landscape, agriculture tied the social and economic layers together. The multifunctional and holistic production of food, the production of building materials and facilitation of biodiversity can be the platform for self-builders to start up their system. This is how the local material economy and communal self-reliance can strengthen community engagement and ground self-build architecture further in its local context. From here, users can take ownership of their homes, materials and impact on their surroundings.

The results show that the relationship between a vernacular building typology and the surrounding landscape is complex and multilayered. Projection onto the modern context propagates this complexity, characteristic for the field of regenerative sustainability according to Du Plessis (2012), even further. Self-building lends itself well for a regenerative approach because the owners are closely involved in the building process, they are able to make choices based on local and temporal conditions and are to be deeply rooted in the community. The goal of the research to give self-builders the means to build their home, similar to the aim of the Segal method, and the implementation of a regenerative approach require compromises. Succes of the project lies in simplifying technical issues and the building method amidst the complex systems and dependencies wherever possible and encouraging users and other stakeholders through presenting the social and economic advantages of regenerative self-building. These are the type of conclusions that are relevant when drawing up design guidelines for self-build projects, such as the ones presented in appendix 6.

VII. Discussion

The case study (chapter 3) proved to be appropriate for getting a wider context and filtering relevant details for understanding the relationship between landscape and the farm. However, the results are limited to farms of the hallenhuis typology and the site specific context of Drenthe likely generate different results than other regions of the Netherlands or even other countries. Nevertheless, the broader conclusions are replicable as they are based on wider theories on vernacular farms and landscape types that are present outside of Drenthe too. It is even desirable that research on regenerative and bioregional approach, that build on the notion of locality, is context-bound. The SWOT analysis on regenerative building materials (chapter 4) proved to be a well-suited method to systematically explore the viability and implications of an regenerative approach for building material production in Drenthe in the modern context. However, the complexity of the dependencies of the ecosystem and the building industry are oversimplified. Also a quantification of the building materials that could derive from a regenerative landscape could have attributed to the wider field of academics. The comparative approach of the final section (chapter 5) is usable for a wider audience as it paves the way for self-builders to build more regeneratively. However, the large differences in historical context, location and building regulations between the hallenhuis, Segal and future self-builders may have influenced the results of this chapter.

Based on the findings, further research could explore: 1. Comparative studies in several regions of the Netherlands to identify universal principles and regional rules of vernacular building materials for Dutch self-builders. The research could be bundled with the research done by the Bouwtuin team (Smit et al., 2022) and other similar researches. 2. Quantification of the environmental impact of introducing regenerative policies and technical innovations through life cycle assessment (LCA). 3. Expanding the scope or zooming in on a different academic field that is affected by the proposed changes, such as food production and landscaping.

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APPENDICES

Appendix 1: Glossary

- **Bioregionalism**: A concept focusing on the geographical, environmental, and cultural uniqueness of regions, advocating for the sustainability and self-sufficiency of these regions based on their natural and social resources.
- **Brink** [**village green**]: A central, open space in a village, traditionally used for grazing livestock, community gatherings and tree supply (Kleijn, 1984).
- **Celtic fields**: Ancient, small field systems typically found in northwestern Europe, characterized by their rectangular plots and low banks or ditches (Provincie Drenthe, n.d.).
- **Critical regionalism**: An approach to architecture that seeks to counter the placelessness and lack of identity in modern architecture by incorporating contextual elements of the local culture and geography.
- **Commensalism:** One organism benefits, and the other is neither helped nor harmed (ecology).
- **Competition:** Both organisms are harmed by the interaction as they vie for the same resources such as food, space, or mates (ecology)
- **Deel** [**Threshing area**]: Working area in a farm where machinery is stored and grain is separated. In Drenthe, there was mostly livestock, but the name remained.
- **Dekzand** [**cover sand**]: Sand deposited by wind action during the late glacial period, covering older sediments and forming the top layer of the soil in some areas.
- **Dors** [**Threshing area**]: See deel.
- **Dwarsdeeltype** [**working-floor-across type**]: A hallenhuis farm layout where the parting doors are situated on the side of the farm instead of the back.
- **Esdorpen** [**domed land**]: Villages on sandy grounds, characterized by their central green area and surrounded by arable fields.
- **Essen** [**elongated fields**]: Long, narrow fields that are characteristic of the traditional agricultural landscape in northern parts of the Netherlands.
- **Friese Groep** [**Frisian farm group**]: A classification of farms typical of the Friesland region, characterized by specific architectural and functional features such as the deel in the side aisle and parting doors in the back.
- **Hallenhuis** [**Aisled hall house**]: One of the five main types of farms in the Netherlands mainly found in East Groningen, Drenthe, Overijssel, Gelderland, Utrecht and the edge of Zuid-Holland and Het Gooi. Also Halle(n)huisboerderij, Nederduitse halle(n)huis, hallehuis (Dutch); Aisled hall house, Low German house (English) (Hallenhuisboerderij - Agriwiki, n.d.). For this research, the Dutch name is used as the English term is less specific and not related to the region.
- **Hallenhuisgroep** [**Aisled hall house group**]: A classification of farms belonging to the aisled hall house type, sharing similar architectural and functional characteristics.
- **Holistic**: "Holistic systems take into account all the variables and perspectives of a given problem, consider them valid and try to account for them to eliminate externalities" (Fleming & Roberts, 2019, p. 110).
- **Hondsrug**: A ridge of higher ground in the provinces of Drenthe and Groningen, formed during the ice ages and characterized by its sandy soil and elongated shape.
- **Kanthaak** [**hook**]: A tool or structural element used in traditional building or farming practices.
- **Keileem** [**boulder clay**]: A dense, clayey soil containing boulders, deposited by glacial action.
- **Langsbalkgebint** [**longitudinal beam frame**]: A type of structural framework in traditional timber construction, where longitudinal beams play a significant role in supporting the structure.
- **Lös huus** [**open house**]: A type of traditional farm layout with an open interior space, without internal walls dividing the working and living areas.
- **Marke** [**common land**]: The land belonging to an esdorp, used collectively by the village community.
- **Markelanden** [**common lands**]: Areas of land used collectively by a community, typically for grazing livestock or other agricultural purposes.
- **Mutualism:** Both organisms benefit from the relationship (ecology)
- **Middenlangsdeeltype** [**working-floor-along-the-middle type**]: A type of farm layout where the working floor runs along the middle of the building.
- **Naald en goot** [**needle and gutter**]: Traditional construction techniques or elements, specific details need context-specific explanation.
- **Overganstype** [**transition type**]: A classification for farm layouts or building types that show characteristics of more than one traditional type, often reflecting a period of transition.
- **Parasitism:** Parasitism is a type of ecological relationship where one organism, the parasite, benefits at the expense of another organism, the host. The parasite derives nutrients or other benefits while harming the host, although the host is usually not immediately killed (ecology).
- **Potklei** [**peat clay**]: A type of clay soil that contains a significant amount of organic material from decomposed peat.
- **Potstal** [**deep litter**]: A traditional livestock housing method where animals are kept on a deep layer of bedding material, which absorbs waste and composts over time.

- **Regenerative approach**: A method of construction and land use that seeks to restore and enhance the natural environment, often focusing on sustainability, biodiversity, and resilience.
- **Staatsbosbeheer**: The Dutch government agency responsible for managing national forests and nature reserves.
- **Stookhut** [**Boiler house**]: A small building or space within a farm used for heating, often for drying crops or providing warmth in winter.
- **Streekdorp** [**regional village**]: A village typology that developed after the esdorp. The narrow plots are oriented alongside the road. The peat industry in Drenthe gave birth to the modern streekdorp that is orthogonal and repetitious.
- **Tectonics**: The art and science of construction, particularly the use of materials and the way they are assembled in building structures.
- **Vernacular architecture**: Architecture characterized by the use of local materials and traditional building techniques, reflecting the cultural and environmental context of a specific area.
- **Zoddenschuur** [**turf/sod shed**]: An open shed using the same type of construction as the farm to store and dry narrow heath sods or turf for fuel. Sometimes one side was closed off.

Appendix 2: Condensed Literature Review Regenerative Approach and Principles

Sustainable models prioritize socio-technical systems and the triple bottom line, while circular models focus on economic and material productivity (Geissdoerfer et al., 2017). Following *The Limits to growth* in the 1970s, holistic views on land use and landscapes continued to inspire books such as *Regenerative Design for Sustainable Development* by John T Lyle (1994) on regenerative design and *Design with nature* by Ian L. McHarg (1969), a book on ecological design. Eric T. Freyfogle's *The New Agrarianism* (2001) underscores this approach within the agricultural field as does the permaculture concept of Bill Mollison and David Holmgren (Hes & Du Plessis, 2014). Recent studies emphasize the need to move beyond sustainability towards a regenerative paradigm (Konietzko et al., 2023). A shift from a mechanistic to an ecological worldview (Du Plessis, 2012; Mang & Reed, 2012).

Lyle's principles for regenerative design (1994) are:

1 Letting nature do the work
2 Nature as model and context
3 Aggregating, not isolating functions
4 Optimum levels for multiple functions
5 Matching technology and need
6 Using information to replace power
7 Multiple pathways
8 Common solutions to disparate problems
9 Storage as a key to sustainability
10 Form to facilitate flow
11 Form to manifest process
12 Prioritize for sustainability

Indications for regenerative landscapes according to Lyle are then:
locality: regenerative landscapes grow from natural and cultural patterns of its place
fecundity: rich in organic growth and organic decay
diversity: reflects diversity in ongoing interactions of its elements
continuity: it is never fragmented, even when going through inevitable changes
(Hes & Du Plessis, 2014).

Appendix 3: Results SWOT Analysis Chapter 4

What are the **opportunities** and **implications** of introducing production in the ecosystem of Drenthe to meet the demand for regenerative building materials?

		S	W	O	T
ENVIRONMENTAL	Resource availability and boundaries	• Sand easily available • Loam layers locally close to surface • Historic proof that building materials can be locally mined • Diverse landscape conditions allowing different crops and material mining	• Peatclay in protected reserves and limited reserve • Currently little wood production in Drenthe • Clay mixed with field boulders and pebbles • Wood production currently not yet a a high priority for Staatsbosbeheer (1. protect, 2. experience, 3. utilize) (Van Son, 2024)	• Upcycling waste streams: excess of natural grass, pruning cuttings and wool • Pebbles, onsite earth and field boulders for foundation • Government wants to add 40.000 ha of forest (Joziasse, 2024) • Use agricultural land for forestry (rich and more clayish) (Joziasse, 2024) • Lisdodde, hemp, flax and elephant grass can be grown as building material in landsapes (Smit et al., 2022 ; College van Rijksadviseurs 2023) • Reed can grow if water table goes up or import from Kop van Overijssel • The 'grove den' in 2022 36,9%, oak 17,4% and lariks 7,3% of forest area (Kuwi, 2022) and thus highest highest wood stocks currently	• Trees need to be planted now to ensure future timber stock • Resource depletion of traditional resources: oak trees (slow growing 60 years), peat clay (non-regenerative), river clay (limited production) • Sand is not renewable and can lead to habitat destruction, erosion and can alter water tables • Proposed areas' soil quality can't sustain new forests (Joziasse, 2024) • The question how many building projects can be supplied with regenerative materials within 100 years remains
	Impact of growing materials	• Regenerative materials usually lower carbon footprint	• Baking of bricks and rooftiles high carbon footprint and energy consumption. • Bricks now imported regionally	• Building elements that don't need high temperature treatment such as adobe bricks (Lengen, 2008). • Production forests can be multifunctional. Recreation, production and biodiversity (Joziasse, 2024) • Regenerative forestry can become part of Staatsbosbeheer's policy allowing produtio, protection and experience to exist alongside one another.	• Increasing wool production would mean increase in methane (Remmelink, 2022) • Woodbanks are important for biodiversity and should not be cut down (Nationaal Park Drentsche Aa et al., 2024) • Risk of monoculture by farmers of regenerative grops induced by efficiency goals • Mining clay and peat induces subsidence and a lower water table
	Change in ecosystem and climate	• Vernacular materials fit to local climate	• 'Pijperstrootje' is supplanting heath	• Multifunctional forests with more diverse trees can restore balane between coniferous and deciduous trees (Joziasse, 2024) • Sheep can retake place as heathland maintenance again, replacing machinery. Sheep manure as natural fertilizer (Joziasse, 2024) • 'Pijperstrootje' can be used as roof thatching (Smit et. al, 2022) • Higher water table facilitates willow and reed production	• Suitability or circumstances for regenrative materials to grow might change with climate change • Pines are struggling as they are non-native to the Netherlands. The sandy soil does not cointain enough water in winter and the trees become prone to insect pests (loss of tree resin) • Increasing nitrogen levels inhibit growth of trees (Joziasse, 2024) • Municipality thinks straightforward and short-term thinking is a risk for monoculture and lack of biodiversity (Kleijn, 1984)

What are the **opportunities** and **implications** of introducing production in the ecosystem of Drenthe to meet the demand for regenerative building materials?

		S	W	O	T
TECHNICAL	Vernacular knowledge	• Knowledge on repair and maintenance • Resilience and adaptability of timber structures		• Incorporate knowledge on repair and maintenance in use phase • Use of willow branches or rope instead of metal wire to thatch roof	
	Building knowledge and skills		• Traditional timber construction turned into specialised knowledge in modern context	• Prefabrication • Eco-building techniques that are not widely used yet such as straw bale construction (Ernst, 2011)	• Balance prefabrication and relationship resource
	Material properties	• Sand soil has good load-bearing properties	• Regenerative materials tend to have shorter lifespan and need more maintenance than linear materials (plastics, concrete, etc.) • Straw and heath sod roofing deteriorates faster than reed.	• Optimal use of material and composites properties. Examples are a combination of selfbearing and insulating properties of hempcrete or light clay, a wattle and daub infill (straw, reed or woodchip with slurry clay), that is half the weight of adobe (Broome, 2008) • Solid Laminate Timber Systems (CLT, GLT, LVL, NLT, DLT, interlocking CLT) (Cramer, 2023)	• Regenerative materials tend to have shorter lifespan and need more maintenance than conventional materials
	Logistics			• Multifunctional forests (Joziasse, 2024)	• Heavy machinery to cut and strip trees damage soil life (Van Son, 2024) • How to store biobased materials in such a way they won't deteriorate
	Regulations		• Traditional method may not need current building codes • Low fire safety of traditional reed roofs	• Governemnt regulations could accommodate regulatory changes to traditional methods • Combination of insulated and closed roof with ventilated cavity to prevent fire and rotting of reed	• Current building codes demand thick insulation packages for regenerative materials
	Research development			• Innovative application traditional materials	

What are the **opportunities** and **implications** of introducing production in the ecosystem of Drenthe to meet the demand for regenerative building materials?					
		S	W	O	T
SOCIAL	Health			• Multifunctional forests (Joziasse, 2024)	
	Safety		• Low fire resistance traditional reed roofs	• Low toxicity in biobased raw materials	• Some treatments of materials (such as timber) or processing (lime) can be harmful
	Cultural acceptance	• Local materials blend more with surrounding landscape		• Local material production increases awareness and responsibility for depletion closer to users	
ECONOMIC	Viability				• Market competition with conventional building industry
	Ownership			• Current farming industries can transition from an agricultural monoculture business model to polycultures serving both food and the construction industry	• Farmers might need subsidies to transition from (livestock) food production to partly building material production for different machinery and processing.
	Market demand		• Mowing and pruning waste by Staatsbosbeheer is now dumped for free at farmers or downcycled through shredding (Joziasse, 2024 ; Van Son, 2024)	• Natural grass mowing waste and forest pruning waste could be used for building materials first before being used as livestock food, fertiliser, composted or combusted as biofuel (Joziasse, 2024 ; Van der Son, 2024) • Production of regenerative building materials could be part of revenuemodel farmers (Joziasse, 2024) • Wool is thrown away, has little market demand	

Appendix 4: Principles Segal Method

Steps building process:

1. Modular grid
2. Layout drawings
3. Structural layout
4. Calculations
5. Framing drawings
6. Schedule of materials
7. Catalogue of elements
8. Building instructions

Building order

1. Foundations
2. Structural frame
3. Roof
4. Floors
5. External walls
6. Windows
7. Partitions
8. Ceilings
9. Stairs and other features
10. Services

(Cooney, 2015)

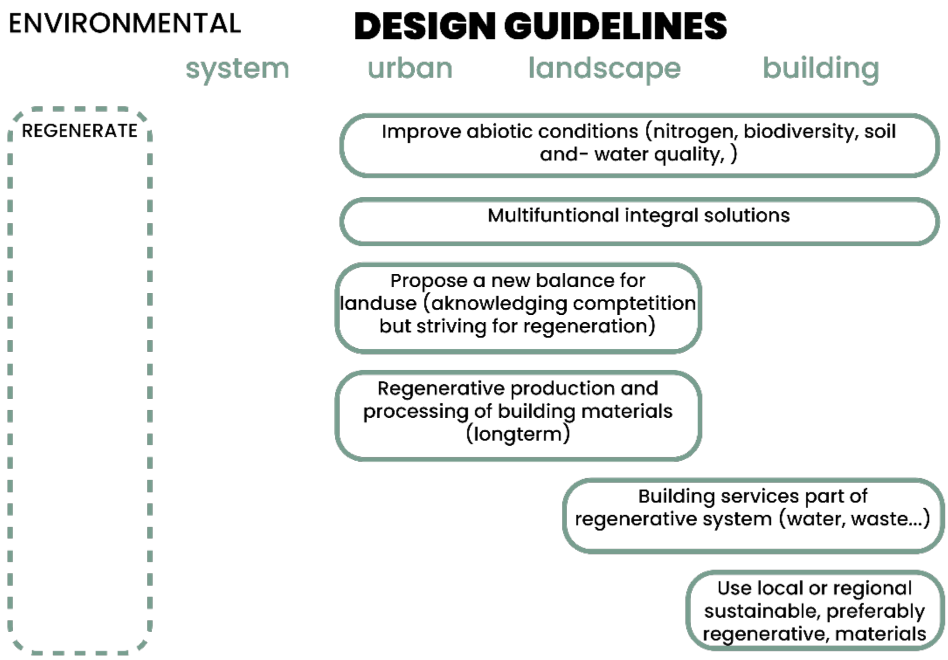
Appendix 5: Results SWOT Analysis Chapter 5

How can the opportunities and barriers of the vernacular architecture of farms in Drenthe inspire modern self-building methods?						
		S	W	O	T
ENVIRONMENTAL	Resource availability and boundaries	• Oak wood is a durable hardwood fit for supporting structures, pine a fastgrowing tree	• Oak trees grow slow. It takes 30 years before the thinning wood can be used for lumber and over 120 years for 60cm logs	• Increase onsite biodiversity with multi-functional biomass production (material stock, biodiversity, soil and water quality, soil structure) • Use younger oak wood for structure if possible	• Not all materials are easy to buy as selfbuilders now (supply chain is missing) • Younger oak wood and thinning wood tends to have more irregularities and has less structural integrity than stems
TECHNICAL	Vernacular knowledge	• Local building tradition enhances community engagement			
	Building knowledge and skills	• The straighforward building order of hallenhuis farms could be easy to teach users • Knowledge for repairing and maintaining applied regenerative materials in hallenhuis might need less specialised workers • Division of specialised workers preparing the structure or finishing the roof and unskilled work forces performing heavy lifting and repetative work • Knowledge of users of farm on how to repair and maintain small issues • Anchor beam truss	• Traditional farm building has become specialised knowledge instead of common craftmanship knowledge. A normal carpenter can't build it anymore (Jans et al., 1980) • Anchor beam trusses are not as efficient in material use as more modern construction methods • The special construction of anchor beam trusses costs more time than standardised timber frame building or light-frame construction	• Skill development for self-builders in regenerative and local materials • Involve users of self-build houses in repairing small issues and maintaining the building components • The straighforward building order of hallenhuis	• Traditional skills and craftmanship are already lost and need new rooting in society • Intergenerational disconnect of younger generations with traditional knowledge • Mortise-and-tenon joints require skill, high labor and the right tools

How can the opportunities and barriers of the vernacular architecture of farms in Drenthe inspire modern self-building methods?					
		S	W	O	T
	Material and component properties	• Oak structures are very durable and can last for hundreds of years • Anchor beam trusses have good stability and strength • Mortise-and-tenon joints do not require metal parts		• Using lighter wood or smaller spans to make it easier to lift building components	• Mortise-and-tenon joints tend to have more material waste than bolted joints
	Logistics	• Mining of resources in historic context was local, limiting transportation (Kleijn, 1984)		• Digital tools as support for building process (step by step plan, calculation tools). Adding tools that (help to) map the evironmental impact of materials (lifespan, carbon footprint) such as The Construction Material Pyramid (DKA et al., n.d.) • Standardisation of biobased materials where possible (bricks, timber, bales, tiles) (Smit et al., 2022 ; Van Lengen, 2008 ; ernst 2011) • Local materials can be supplemented with regional materials, as transportation and communication have significantly improved (Kleijn, 1984 ; Smit et al., 2022)	• Integrating modern technology and traditional methods would need specialised knowledge and management • Risk that standardisation of regenerative materials is not possible due to natural irregularities within materials • Digital tools too general for specific local contexts and supply chains • Current digital tools are not integrated and mainly limited to singular uses (budget planning, cost calculation, project timelines, energy calculations or information)
	Regulations	• In historic context of Drenthe the community and self-sufficiency of the village promoted self-building		• Government policy should facilitate, not complicate self-building in their regulations	
	Adaptability	• The dry connections (wood-and-peg, mortise and tenon) of the hallenhuis allowed for dissasembly • Uniformity of beams and posts was not important and allowed for flexible reuse of structural elements (Kleijn, 1984) • Column structure facilitated an adaptable floorplan (open workfloor to filled in living farm) • Separation of main supporting structure, non-loadbearing walls, roof and facade.	• The hallenhuis was upscalable in the length, preferably in the back, but the width was set. Annexes such as sheepfolds or sheds were built seperately or perpendicular with minimal overlap with the corner of the farm.	• Hallenhuis reused (little modification) timber structures. This versatility can be interesting for self-builders • Integration of building services within one element of the building system to maximise adaptability (sockets in battens in the Segal Method)	• Integration of building services within structure means no separation of building layers, obstructing maintenance and repairs possibly • Mortise-and-tenon joints need to fit perfectly • limited modularity or expansions of the structure of the hallenhuis

How can the opportunities and barriers of the vernacular architecture of farms in Drenthe inspire modern self-building methods?					
		S	W	O	T
SOCIAL	Health				
	Safety				
	Cultural acceptance				
	Community building	• Sense of community in building and operation phase. Barn raising (rearing or raising bee)		• Building process part of community bonding • Building material production can tie self-build community and landscape together as in the quaternity of the es-dorp cultural landscape in Drenthe	
ECONOMIC	Viability			• Using younger oak wood for structure has lower cost than using the stems as they need les grow time, less space and thinning is already part of maintenance	• Potential higher costs of mining and processing certain regenerative materials can deter self-builders
	Ownership				
	Market demand			• Not all materials are easy to buy as selfbuilders now (supply chain is missing)	• Designing the building in such a way it can be taken apart and resold if structurally still sound (Segal's goal) can mean there is too much focus on standardisation with a trade-off with a local production chain

Appendix 6: Design Guidelines



ECONOMICAL & SOCIAL

DESIGN GUIDELINES

system | urban | landscape | building

ENCOURAGE

- Facilitate transition agriculture to agroforestry
- Increase awareness and collective responsibility of regenerative approach
- Increase community engagement
- Catalyst for self-building
- Showcase materialisation and methods

LOCALITY

- Social, knowledge and material hub
- Architectural language true to knowledge, skills and resources at hand
- Limit material processing and treatment that is harmful to health

TECHNICAL

DESIGN GUIDELINES

system | urban | landscape | building

DESIGN FOR SELF-BUILD

- Reduce weight and spans of building components
- Simplify building method, order and connections

DESIGN FOR LONGEVITY

- Design for repair and refurbishment (layers that self-builders can fix)
- Design for reuse of structural elements

DESIGN FOR INNOVATION

- Optimal use of material and composites properties
- Improve vernacular building components to modern standards

DESIGN FOR EXPANSION

- Expandability of timber system and flexibility floorplan

REFLECTION GRADUATION PROJECT

Luka Brandsma, 4831543
Architectural Engineering, flow/make
Tutors: Yannick Warmerdam, Mos Smit, Paddy Tomesen
Board of Examiners Delegate: Christian van Ees

Location:
Schieven, Assen, Drenthe, The Netherlands

<u>Introduction</u>

My graduation project is an exploration of how a regenerative self-build centre in Drenthe can be the initiation of a local building material production system and a physical medium for a network of knowledge, skills, labour and participation.

<u>Research</u>

The thematic research that supports the graduation project investigates how we can translate the relationship of Vernacular Architecture in Drenthe with its landscape to applicable knowledge for regenerative self-building in the modern context. The research consists a paper containing: an exploration of the role of the vernacular 'hallenhuis' farm in the landscape of Drenthe and it's material relation to the landscape, an analysis of opportunities and implications of a future regenerative production of building materials, and finally conclusions on the applicability of vernacular practices to modern self-building. The paper presents data on the geographical, material, economic, social and technical layers of the hallenhuis typology and its surroundings.

There are two main takeaways from the thematic research. The first is the role of the farm. In the historically agricultural-oriented province Drenthe, the farm was the centrepiece in the quaternity of the farming business model (esdorp, stream valley, heathland and es). The hallenhuis was where products were processed and stored. It was the, so to say, headquarters of the agricultural business of the cultural landscape from where the lands and workers were managed, while also remaining the home of the owners. In this metaphor the farmyard, with its functional layout harbouring storage space for agricultural products and building materials, is the industrial estate. The second takeaway is how the farm as a building related to the landscape. The relationship between the architecture of vernacular farms in Drenthe and their surrounding landscape can be best described through a layered analysis approach. The case study shows this layering consists of geographical conditions, soil type, water bodies, abiotic conditions, vegetation, cultural intervention, ecosystem services, social and economic system and finally community engagement and ownership. Each layer building on top of one another leading to a layered model.

The evident relation, presented in the paper, between a regenerative approach and self-build architecture is accompanied by the complexity of problems and opportunities regarding the implementation of a regenerative building material network.

<u>Design</u>

My design is the execution of a timeline for a regenerative self-build strategy that accounts for the role that people can play in a building industry that contributes to a healthy ecosystem. The design is a collection of functions that support the development of such an industry. The centre does not have a housing function, but rather makes sure there is a system to build houses more sustainably in a local context.

The buildings and the surrounding landscape are designed according to four main themes: regeneration, education, community engagement and production. All these functions have different effects on the functioning of the design, see the figure below.

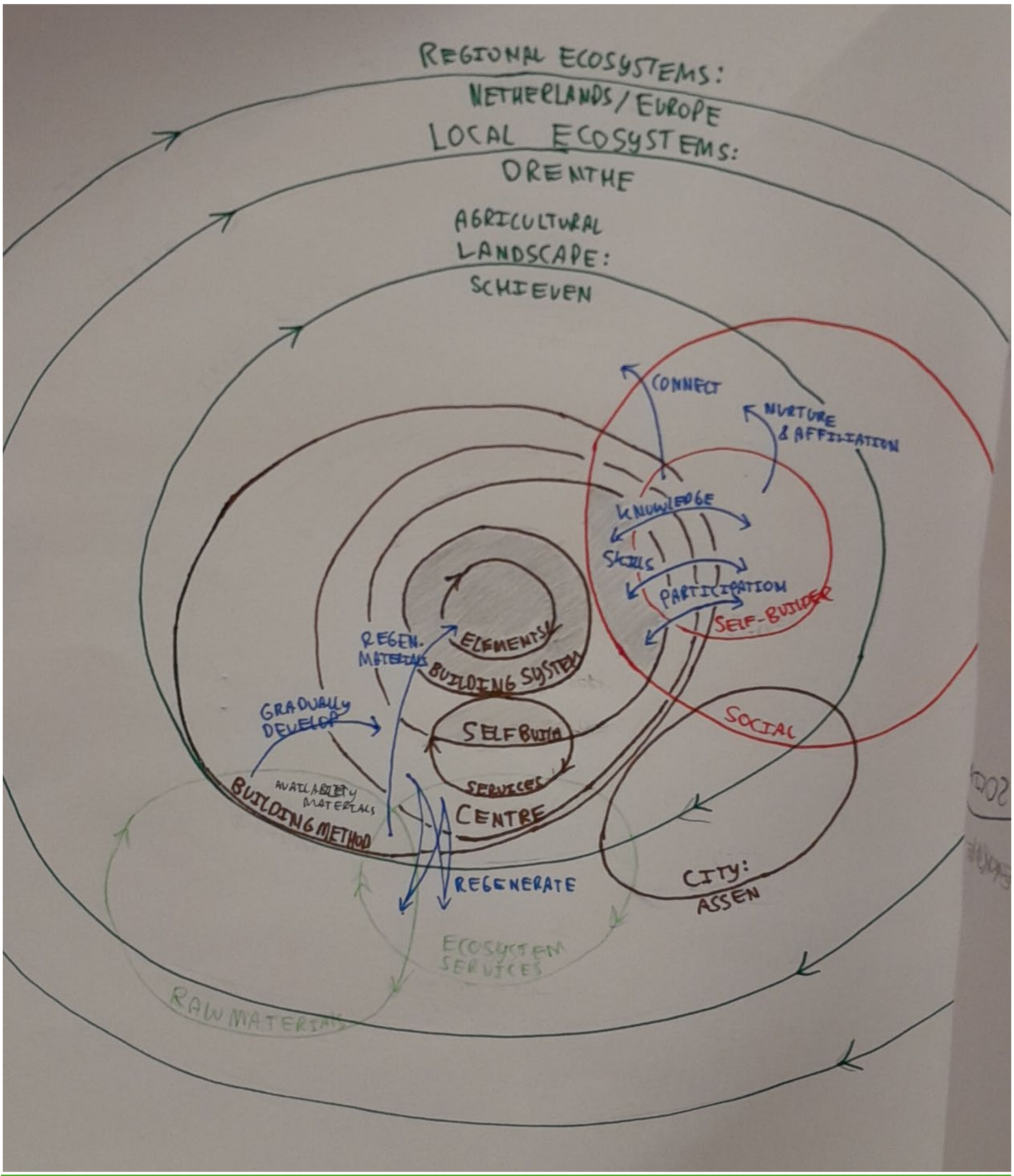
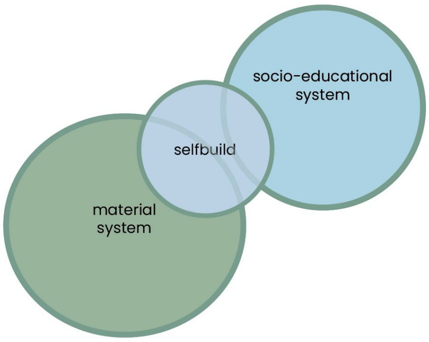


Figure: Design scope and relation diagram. Own work.

If we simplify the relation diagram above to the main principle we get the following figure:



Here we see how self-building is used as a means to facilitate regeneration, education, community engagement and building material production within a local social-economic and material system.

What is the relation between your graduation project topic, your master track (A, U, BT, LA, MBE), and your master programme (MSc AUBS)?

Studio theme: make & flow

By researching regenerative building materials and looking for historic clues on socioeconomical system in local farms of Drenthe, I aimed to tie the building to the landscape, the material to the flow. That is why in the first place I believed my project aligns most with the studio topic 'flow'.
However, the self-build criteria has such a great impact on the architectural language. The possibilities and limitations of self-buildable buildings weigh down architectural choices in a way, but also clarify the relationship between designer and builder. That is why my project also falls within the studio theme of 'make'.

Studio

The technical and tectonic oriented approach of the architectural engineering studio is an approach that really fits my project. It is helping me to make ideas and aspirations tangible and concrete. The broader scope of regenerative architecture and research field of local building materials are tied together in the iteration and research of a self-build building system and different building methods.

Master track

Within the Architecture track the project investigates the effects of materialization and the important relationship between the design and the building process. The wide scope necessary to understand the complexity and functioning of the ecosystem services in collaboration with the natural system pushes this research beyond the field of architecture to explore the fields of urbanism, landscape design and ecological studies. I also find myself involved in exploring policies surrounding self-building, land use and ownership.

Master

The regenerative approach asks for a broad perspective on the built environment, so it is not unthinkable that this project does not limit itself to architecture alone, even if that is the main focus of the design. Social aspects in the project (such as community engagement and participation) are not only a goal. They are an integral part of the design approach and function as a means to a common goal: build with local materials and regenerate damaged agricultural land. This project deals with a wide variety of aspects of the different chairs and tracks within the faculty of Architecture, Urbanism and Building Sciences.

Connection Research and Design

How did your research influence your design/recommendations and how did the design/recommendations influence your research?

I expected the research to be of use for the design in several ways. First of all, the research paper was supposed to be the academic backbone of the project. I think I expected it to include more direct results and result in very clear design principles in the end. However, the thematic research paper was, more than a collection of all research, a deep dive into the complexity of sustainable building materials, regenerative design and the context of the project. This enormous amount of information still had to find its way into clear design principles.

In my paper I did try to find patterns between landscape and building in the case study on historic farms in Drenthe. This search for making the relationship between building and landscape tangible (by first finding it in the research) and then applying that to design concepts was a process of trial and error. Initial findings that seemed very relevant at first ended up fading to the background and results that seemed irrelevant at first, surprisingly became important for the project.

An example of this is the research into the layout and functioning of the 'esdorp' in Drenthe, specifically the 'brink'. I believed at first I would reference to this phenomenon quite literally in my design. However, I found that the multifunctionality of the brink as a physical meeting place, a collective building material stock and communal activities did not have to be taken literally. I found inspiration in principles that were used in the history of Drenthe instead of referring to them.

Another example is how the analysis of the main supporting structure of the 'hallenhuis' and the case study on the 'Segal Method' seemed to lead to the development of an improved, modernised supporting structure. Although I believe that is what is evident in the design right now, I think the analysis of the function of the farm, the different spaces of the farm, have brought the design more. This is where the regenerative approach and practicality meet. How are these spaces used and why are they used that way. My understanding of the intrinsic link between space and material changed. It is not just material you shape your space with, your space can also follow the needs and optimal qualities of your material.

As soon as there was more clarity, after P2, on the design principles and how certain research conclusions could not only feed my design, but also enrich and influence them, I continued designing and researching alongside each other. In design sessions I tested and combined principles with approaches I found in research. An example is how I compared building methods suitable for regenerative building materials. I used my research results to help me define the criteria for these building methods. I assessed the building methods on aspects such as material regeneration, self-buildability, simplicity, building time, availability of materials, suitability for the Dutch climate, cost, flexibility to build over time and building order. Then I researched by design to test how these building methods could be grouped together into a building system to simplify the application. To establish groups of building methods I arranged them according to, for example, preferred façade grid size and wall thickness.

Another example of research that fed my design while I was already designing is how I analysed and compared the building and planning phases for self-building to conventional phases. This was necessary for me to better understand the differences and limitations self-builders deal with. Need for expertise, availability of tools, safety regulation, quality assurance are a few of these limiting factors. I had looked into them before, but now I was designing I could see the consequences better of the limitations.

While I was designing the building system, using side researches to improve and fine tune all aspects of the system, I also kept on researching building materials and origins. With the exploration of possible building methods to use, came new questions on the applicability of building materials I had proposed in my research. Certain materials that I did not consider before were replacing assumed materials and some materials I was planning on using (more extensively), were reduced. An example of this is how believed at first I would use peat clay to make adobe bricks. However I found out the peat clay area's that are left are in protected areas. Instead, I went to the site itself to investigate if the loam in the agricultural lands of Drenthe could be used as building materials, which it can. This means less mining off-site and circular use of materials on-site. From my research I knew I wanted to, or fill up the agricultural irrigation system to restore the water table, or at least make a gradient. Now I knew I could use the loam, a meaningful purpose was found for the excavation.

The continuous research on building materials, building products, raw resources and processing techniques were needed to understand the material systems that were in place, were missing and what was needed to install a local building industry. Especially my research in timber processing, drying, sawing and the differences in how timber is processed have had a big impact on the design. Besides from designing good architecture, I had to make sure I knew where the materials came from. This research gave me insight in if I was wasting material or if I had unrealistic expectation of how building elements would be produced and how it would function.

Also the properties of materials and the grow cycles (especially of trees) were an important part of my research. Although this research has happened on the backend (I have a huge Miro board with a collection of data), the limitations of time and availability of resources were essential in the choice of materials, but also for the whole approach of the design. The reason the design is built in different steps is because of the limiting resources (time, materials, production chain). My design became the process of an alternative building industry itself.

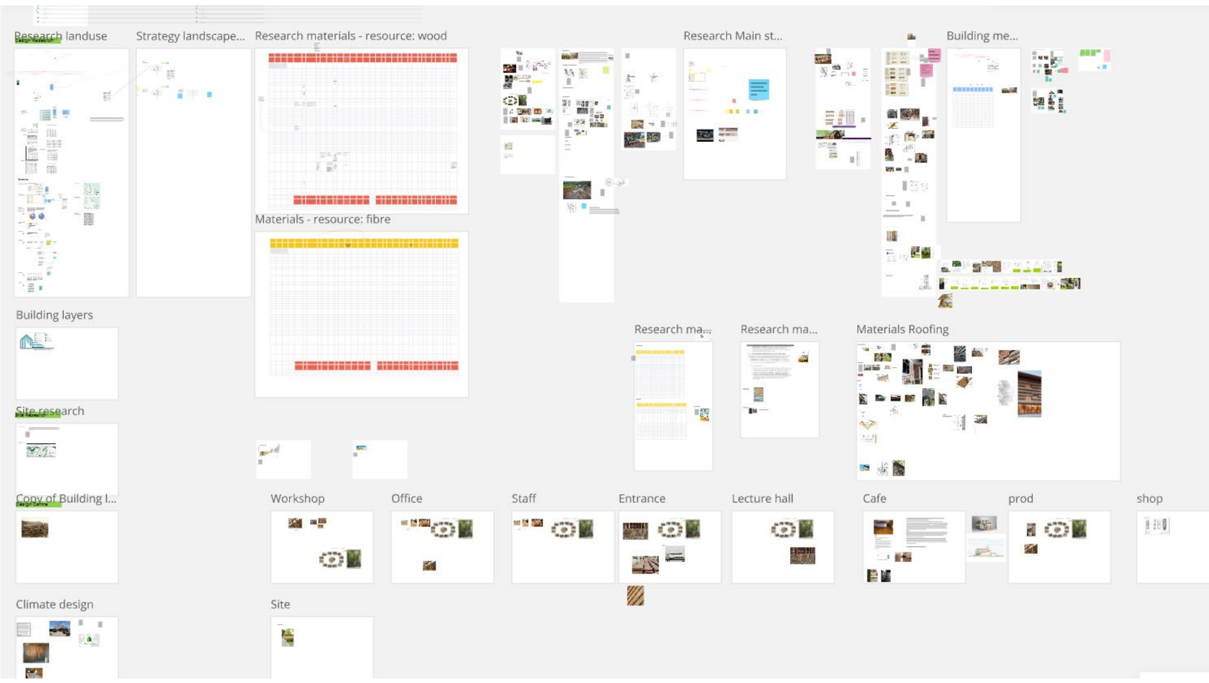


Figure: Miro board containing research results and design decisions. [1]

[1] From top left to bottom right: data forestry management, vision province and forestry management, my regeneration strategy, material properties and grow cycle matrix, material research, building method research, detailing research,

In my research plan I intended to compile a handbook for self-builders. A way to collect my research and show the process, like in the book 'The Barefoot Architect'. However, writing a book that is so detailed and multifaceted would be a long-term task. However, while designing and trying to collect all research results, I started to realise that my design itself is intended as that handbook. From the start I knew I wanted the building to inspire self-builders, show the possibilities and limitations of building with regenerative materials with your own hands. I think as soon as I started to embrace this I could switch from endlessly researching to designing. I cannot show all options and all problems associated with the field of regenerative architecture. What I can do however is design a building where the regenerative approach is visible in a story. From the site design to the building system, from the climate principle to the detailing of the window shutter.

I think first I had to learn the alphabet of regenerative architecture (the thematic research on materials) and I needed to learn how to read (case study analysis, site analysis).
Then I need to pick my first words (analysis of building methods, building layers, climate principles, self-building demands, climate control demands,) to start making sentences (design iterations). How the design then developed over time is the story, and like any other story, you can always tell it differently or tell other stories. This graduation project has become the story that I wanted to tell, to add to other people's projects, but even more so, to inspire and engage myself in this niche of Architecture.

<u>Approach to Method</u>

I think there are two sides to my approach to this project. On the one hand I think I wholeheartedly embraced this challenge to dive into this new area of architecture. It is a type of thinking that suits my qualities, thinking outside of the box and being able to get to the bottom of things and understanding systems. I think the way I tried to view the issues of my graduation project and research from different angles and different scales is something that has helped the project. Combining historical and site context information with in depth interviews with experts and users have given me a pretty good idea of the complexity and limitations of regenerative architecture and the material flows in the sustainable building industry. The smaller design researches have helped me to gain some sense of how to put my ideas into practice and how to combine them in an architectural design that speaks for itself. I think it really helped the project that I am passionate about this topic to keep on going.

However, this also had a downside. Because my approach has also made the process difficult and draining. Because of my forgoing interest into the topic, but also struggles to prioritise (which is sadly inevitable for my brain type) I ended up in a few rabbit holes. The first one was the historic farm case study. Looking backwards I spent too much time on this, hoping to derive all main design principles from this. The second being the material research. I expected a clean list of usable materials would come out of the research but this was not the case. It was more like a big pile of information that I had to sift through and make choices in without feeling like I had the experience to do so. Because of my approach of looking at the problem through scales and especially through time, I think my scope became too big. It is difficult as the field of regenerative design is an holistic approach, which I tried to implement. A big downside to this is that I spent a lot of time trying to understand the underlaying systems which ended up making my time management and prioritising harder.

I think a flaw in my methodology was the detail level of information I was trying to collect and derive from. For example, it was important for me to understand how the vision of the forest management influenced my project. This was the right detail level. However, I have also spent hours on researching the material flows of sawmills, machinery, foundations, soil types etc. I think I lost myself in those details because I felt like I needed to understand them to the degree that I could make choices about them. I learned that sometimes it is better to make preliminary decisions to reflect back on later in the process. I think this is not just a flaw in my methodology, but in my approach in general. I am trying to trust the design process more, but I also have experience in losing priorities and forgetting important details that 'kill' the design later on. My challenge is finding the right balance in reflecting and zooming in.

<u>Feedback</u>

At my P2 I had received the feedback that my story was not coherent and they were trying to find my core. At that point I was too overwhelmed by the complexity of the project and I think indeed, I had difficulties finding that clear core. Through explaining my project to friends, family and others I discovered slowly what my priorities were. For example, that although self-building was not the main goal, it is a means to achieve the ultimate goal (reconnect human practices in the building industry to the natural flows of the ecosystem) through community engagement and a sense of ownership.

Another point of feedback that I have gotten in the later stages of my project was to start producing and put things together. I had some difficulty with this feedback as I was working really hard and trying to produce as much as possible. Where the feedback in the beginning of the building technology sessions were very positive about my approach and my way of testing and tasting, this quickly changed into comments that I had to work harder or now really start designing. However hard that was, I think what they meant was that it was time for me to start making choices. I did not want to keep my options open, but I felt like there were too many questions unanswered, or I was going back and forth between two or more options.

Something I learned from this was that I needed to start making intuitive design choices and trusting in all the background research I had done. I do think this is hard in a situation where you are exploring a way of architecture that derives from another perspective. Not from the designer but from the material. That is what I was trying to do. However, this lead to my priorities staying with the design. At some point my mentor told me (after P3) that he did not worry about my capabilities, but that I needed to start to shift my attention to the design. I think this was an important moment for me, because only then I saw how stuck I had gotten myself into the limitations.

Feedback on the architectural concept and my story were very welcome. It was pointed out to me that certain ideas were clear in speech, but could be better translated in the architectural language. I think this was really helpful to take a step back and look at my design as though I had never seen it before and I also noticed those little disruptions. This mainly had to do with configuration of the buildings on the site and how the building would be perceived from the main road. It was time for me to begin thinking like an architect and not a researcher anymore.

<u>What I have learned</u>

In this project I have learned to follow and trust my passion and intuition but especially that if you start trusting on them you can thrive. This is a feeling I lost during the process, but recently has come back in bits. This project for me is also a way of dealing with my perfectionism and my neurodivergent brain. As my previous approach was more 'making sure you work twice as hard to get it done' I am now taking a new road. One with more support and mildness to my own process problems.

How do you assess the value of your way of working (your approach, your used methods, used methodology)?

My approach to look at the project through different lenses and holistically has helped me to start to understand a full system. I think it is really valuable for architects to understand the system they are working in and not just take the conventional design choices as a base. In order for Architecture to innovate it is not just about designing new buildings. I think we should start designing the building industry as well. Not alone, but in combination with other industries that are involved. There are more and more examples of collaborations between forestry and agriculture. Industries should reflect on the energy and materials they are using and wonder if they are making the best choices, or just the ones that are easiest to make.

I have found however that it is also important to not lose yourself in the complexity, but use it as a bigger reference frame and taking moments in the design process to reflect on the bigger picture and if your design is telling the story you want to tell as a designer.

<u>Value graduation project</u>

This project aims to inspire both individuals within and beyond the building industry to embrace regenerative principles. By demonstrating the societal benefits of reconnecting with nature, it encourages practical application. The project introduces self-builders to an alternative, potentially transformative choice for sustainable living amidst urban expansion and housing challenges.

In the professional field of architecture, this graduation is adding to the growing research on the possibilities for regenerative building methods. It also invites architects to rethink their role as a designer. What if we design the conditions, the possibilities and let people design their own space? The urban execution of a regenerative approach to housing might not seem as tangible currently, but can have potential in the long run. Interest in sustainable community living is growing. Though located in the context of Drenthe and the Netherlands, the design's focus on self-builders using regenerative materials can spark broader industry reconsideration. This suggests a need for systemic evolution where this design can contribute to catalysing a truly sustainable future.

The research aspect of this graduation project is mainly an example on how to learn from past and apply this knowledge to propose modernised approach for a regenerative relationship of buildings and the landscape. The research is relevant to self-builders, architects interested in biobased and sustainable design, planning departments of municipalities and governments, farmers and any concerned citizen interested in learning about sustainable efforts in the building industry.

As the research is set in Drenthe this province will find this information the most relevant. However, other regions with similar soil types and ecosystems can still benefit from the information. Researchers looking at other biotopes can take a more general look and use the applied methodology of the research as an example for their own research. As soon as Dutch institutions are genuinely interested in adopting a similar approach to their city expansion this study, together with existing studies in the Netherlands, can be seen as a starting point. A larger research with more data collection is advised before implementation.

Thus, the project is relevant to self-builders, architects interested in biobased and sustainable design, planning departments of governments, farmers and concerned citizen interested in learning about sustainable efforts in the building industry. The novelty in the graduation project is not in the research results, but in application of this knowledge on a design that is part a bigger and long-term plan.

Transferability

How do you assess the value of the transferability of your project results?

This graduation project was used to explore a bigger aspiration: to find an alternative way to handle resources in the building industry and to regenerate damaged land. You could say the project was a first case study to come to an understanding on the limits and possibilities of the field of regenerative design.

This project is a bundle of the knowledge and experience that I managed to collect in a year of graduation. My role in this alternative building industry then is only giving a suggestion on how it could be done. The idea is that if the centre were to be built, this knowledge only continues to grow. Self-builders and experts exchange knowledge, skills, tools and labour and add to a collective database in the shape of an socio-educational and material production system. As this is a long-term vision, it is only logical that the centre and its use change over time. The centre is not an end-phase.

In the concept of this graduation project also lies the idea that once the landscape in the region of a centre is saturated, production facilities can be easily transformed into homes or other functions. The centre has fulfilled its large scale production purpose, but will continue to support the community and focusses on repairs, maintenance and small constructions.

The idea is that this project could be the catalyser of regional production systems throughout the Netherlands and possibly beyond. As such, this approach can spread and whole regions can transition to a more local oriented building industry. As the locality is so important and context based, the design will look different in other regions. However the approach is replicable and can grow into a larger network where research and knowledge is shared. You could say the building industry is then an institution industry, but then it is a bottom-up institution with large community and beyond sustainability.

Reflect

Own question: What are recommendations that could have given yourself at the start of the project and what are your takeaways from your process?

At the start of the project I would have told myself to consider limiting the scope to either regenerative materials or to selfbuildable homes. Although I believe how the self-buildability supports the regenerative approach, it is a large task in a year time. Also I would tell myself earlier on to trust more in my intuitive designing and not let all the limitations freeze your process.

Own question: How does your graduation project topic influence your position in the field of architecture and career prospects?

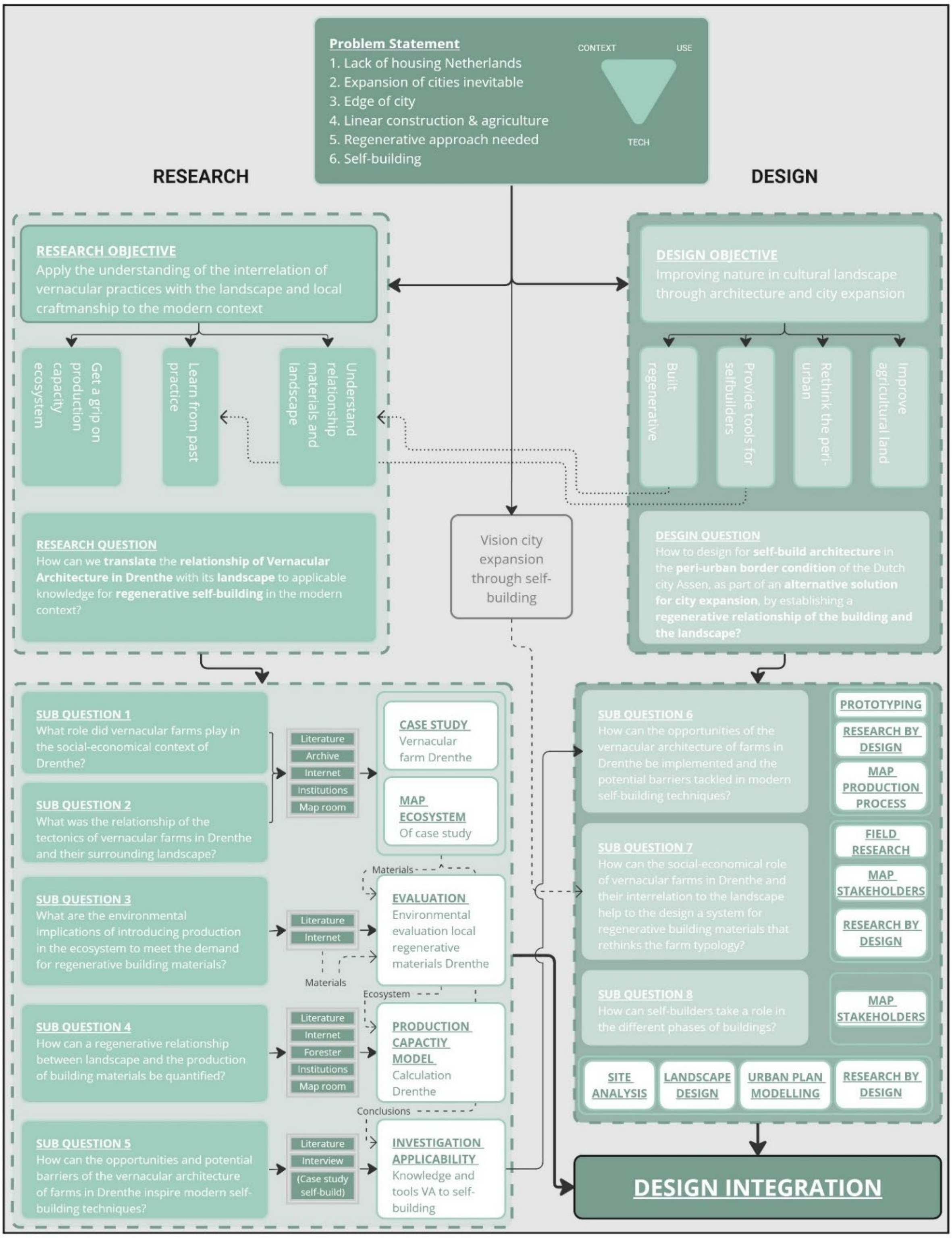
I have noticed that this graduation topic lies close to what I believe in and what I am passionate about. I want to be able to continue designing, but also have the freedom to experiment and research other ways of building. I would see myself working with self-builders, communities, CPO's or an architecture firm that also does research and development. I believe the first architecture firms are slowly making these steps and I am thrilled to be part of this transition. What was also emphasised in this graduation is that I am good at thinking outside of the box and conceptualising, but can really thrive in a team to balance this out. My weaker points (getting lost in details for example) is something that is easier to manage in a team and when there is shared responsibility.

Final part graduation period

My final part of the graduation will have a focus on doing the things I love about architecture. I want to spend my time and energy on making comprehensive models I can use for the presentation. I want to show some materials tests and build a sort of exhibition of my research and project. I have already started collecting materials and samples and continue to do so.

Another focus will be my presentation. I want to improve my storyline and add drawings or improve drawings where necessary to make a clear presentation. I will try to not fix all small details, but rather focus on aspects that really could help to tell my story. I am going to try to do some general calculations for the land use needed to grow the materials so I can change the production field ratio's accordingly. This is something that can only be done now when the cladding and finishing materials were fixed. In addition to this I am thinking about a visual summary of my project, a flyer for the centre, as a way to summarize my project. In my free time I would like to continue editing a video I have started working on that I can show at my P5, but this has no priority and is more of a hobby.

Appendix 1: Research Diagram



Appendix 2: Methodology and deliverables diagrams

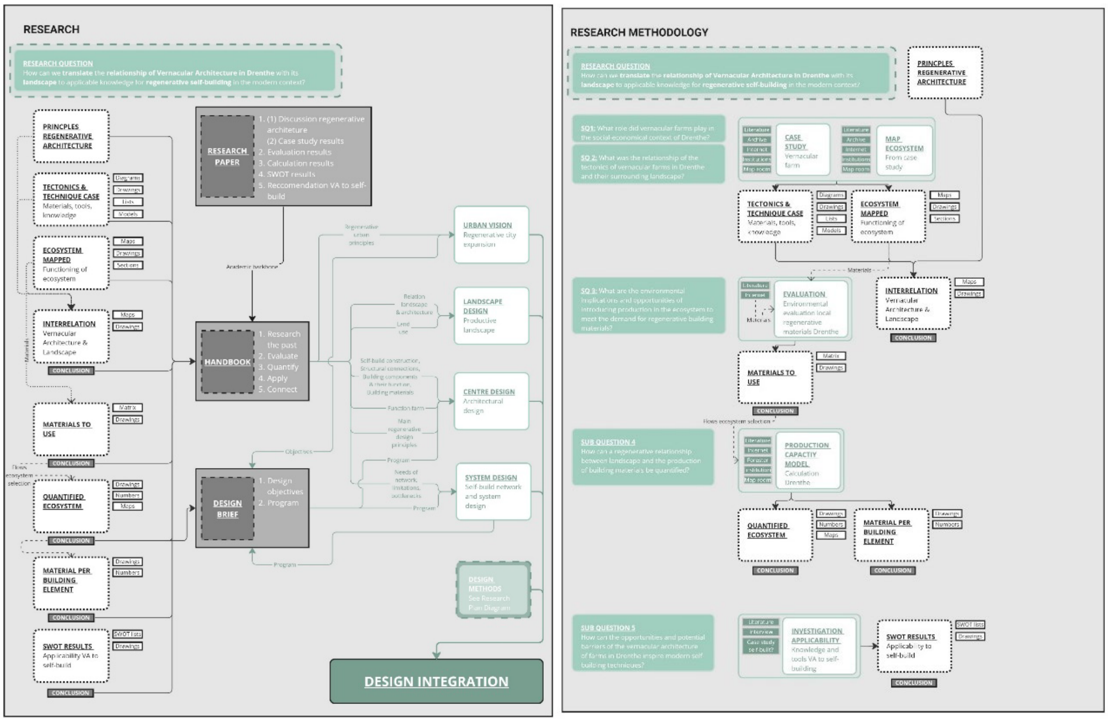


Figure: Research Methodology diagram including outcomes (left) and research outcomes and deliverable (right). Own work.