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A Systemic Design Approach to Sustainable Value Chains in Norwegian Forestry

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This paper is anchored in experiences from coastal forestry in Norway and a three years interregional project aimed at mobilising stakeholders in the value chain from forestry to industry and the end-use of wood-based products, involving politicians and public administration in cooperation networks. This paper argues for and discusses how systemic design approaches should complement today's use of Design Thinking (British Design Council 2004) in this work to tackle complexity and wicked problems (Rittel, Webber, 1973). Compared to its potential, the Norwegian coastal forestry today is in a state of low performance with deeply rooted causes that are not easily solved by innovation events. The Intergovernmental Panel on Climate Change (IPCC, 2021, 2022) is calling for urgent action. It has provided global society with only three years (2022–2025) to start intervening at a systemic level to reduce climate gas emissions over the next 30 years and reach a maximum 1.5 ℃ temperature increase goal.

Global forests are seen as one of the most important means of reducing carbon dioxide through their growth and existence. They also promote biodiversity, timber and bio-fibre substituting fossil-based human-made materials, products and energy solutions (UN Food and Agriculture Organization, 2020). Forests as a resource must be approached using local perspectives and care in parallel with a holistic view of planetary boundaries, including concern for social sustainability.

The Norwegian forestry industry is experiencing resistance towards industrialised logging. This is not an unimportant hindrance to the development of industrialised production and more advanced value chains for wooden resources. Although the volume of forest resources in Norway is increasing (by 12.5% in 2020, SSB), ripe spruce and pine are hard to reach for logging in non-reachable areas. The planting of these forests started approximately 100 years ago with the aim of restoring deforestation caused by industrialisation in all of Europe. This article introduces system traps and opportunities along with Meadows' (2008) 12 leverage points for increased awareness as possibilities for intervention. It also discusses how delays and long-term system behavioural patterns are traps and opportunities to intervene in the archetype of the value chain structure, starting with forestry. However, a surprise to many stakeholders may be the role social systems and information flow play in establishing sustainable value chains. Systemic design may lead the sector to explore relations and connections over time rather than physical elements and somewhat fragmented parts of the system.

KEYWORDS: forestry, socio-ecological systems, sustainability, system dynamics, interventions for change, systemic design

RSD TOPIC(S): methods and methodology, policy and governance, socioecological design

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Introduction

The forests along the seacoast of Norway were almost gone by 1900. Within a period of 200–300 years, the forests on the European continent declined due to city development and industrialisation in Europe aimed at increasing mining and material growth. The national response to this reality in Norway was to replant the entire coastline using pine and spruce trees. Today, 100 years later, the decentralised areas of planted forests contain resources of high value; however, the systems of economy, work life, and political goals embracing the forests and the forestry industry have changed radically. Although the volume of forest resources in Norway is increasing (by 12.5% in 2020), ripe spruce and pine are mostly found in non-reachable areas of the coast. Technology,

monetary systems, communication, and information flows contradict earlier logging structures based on more manual work, as well as the competence and application of timber resources. Some numbers from the forestry industry might be helpful in understanding today's context. In 2020, Norway had 125,485 forest properties (and owners, SSB 2022). Logging was practised in only 12,660 of these properties. This is a decline of 4.5% over the last ten years. However, the volume of harvesting has increased, as has exportation.

Except for the building and paper production industries, complete value chains for high-end products (e.g. furniture) using Norwegian wood resources are non-existent. The consequence of this situation is vulnerable forestry, which is highly sensitive to raw material prices, and the production of low-cost products that may easily be copied and produced in countries with lower labour costs. To a large degree, Norwegian logging has delivered raw materials, both sawn timber and pulpwood, to the paper industry. Approximately 70% of timber/pulpwood sales in the Norwegian market turn into paper. In 2010, a large Norwegian paper factory closed. This led to a severe decline in the demand for pulpwood in the Norwegian timber market, and exports increased. The decrease in demand in the paper market remains a trend. This requires a change in the value chain from forestry to end products and use. The initial system dynamics analyses (Figure 1) show how digital technology affects forestry. Feedback loops are complex and difficult to understand and detect, given the 60–150-year delays (caused by the time a tree needs to grow ripe).

The Norwegian government has called for a change in value chain structures and a high-end market focus. The forestry and wood industries have deep roots in the Norwegian geographical landscape as well as decentralised dwelling structures, old natural households, early building traditions, rhythms of the year in work life, local culture and the human-nature relationship. What role might the Norwegian forestry industry play in the Green Shift, moving from fossil-based energy and materials to renewables, promoting a more holistic and systemic character? The old forestry culture of a long-term perspective and sharing competence among generations are difficult to recall and align with today's expectations of rapid economic growth. The sector is still confronted with a discussion about the validation of scientific knowledge known about

carbon dioxide drawdown in the forests, which is an important driver for the Green Shift. In contrast, today's surrounding systems are also built on short-term economic profit and growth. These are the challenges that the Green Shift encounters as well.

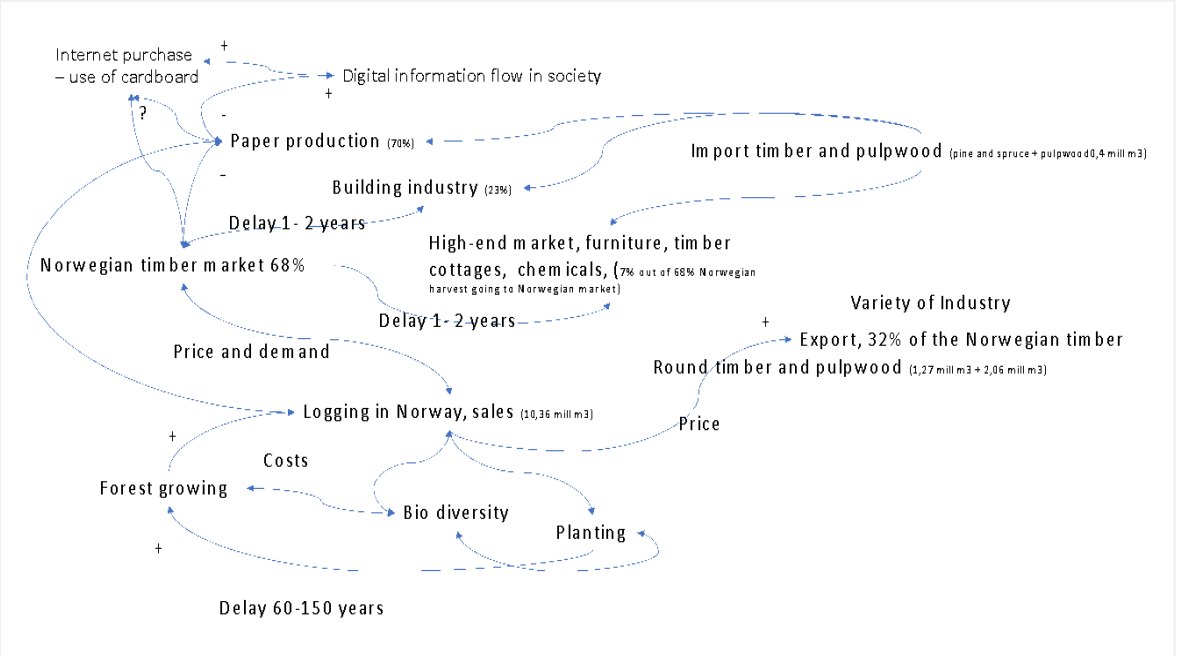

Figure 1. Exploring system dynamics for the Norwegian forestry industry in relation to changes in demand in the wood-based industry (based on data from the Norwegian Directorate of Agriculture (2021) for 2020).

Oak 3000 – The thousand-years-forest (Norwegian: EIK 3000 - Tusenårsskogen) is a regional project in the south of the coastal forest in Norway. Seeds from oak trees from the second millennium are planted in the third millennium for use in buildings and products lasting into the fourth millennium. Our present mindset of time is challenged by Oak 3000. The tradition of timber churches and ships, however, already points a thousand years back in history and shows the possibilities of this material. Not only oak trees but also needle trees and other broad-leaved trees are used. Designing to last was a strong motivation when resources were scarce (local) and enormous manual effort was required to retrieve materials. Now, the motivation should be even larger; the contribution of systemic design may become a strong tool for designing for longevity.

Sustainability principles as new values for change

Socio-ecological systems for sustainability are recommended anchored in sustainability principles that lead to continuity and regeneration (self-organised systems) (Robèrt et al., 2019). These are defined in a manifold of versions in numerous ways; one set, developed by a group of international researchers, was extracted from the root causes of unsustainability in ecological and social systems (Robèrt et al., 2019). Eight Sustainability Principles include three principles concerning ecological sustainability and five principles for social sustainability. Although the future is dependent on sectors merging or growing, in order to replace petroleum activity in Norway (and globally), it must be developed in alignment with both ecological and social sustainability.

The eight sustainable principles derived from The Natural Step (Robèrt et al., 2019) are:

> In a sustainable society, nature is not subject to systematically increasing ... (1) ... concentrations of substances extracted from the Earth's crust. This means limited extraction and safeguarding so that concentrations of lithospheric substances do not increase systematically in the atmosphere, the oceans, the soil or other parts of nature; e.g. fossil carbon and metals; (2)... concentrations of substances produced by society. This means conscious molecular design, limited production and safeguarding so that concentrations of societally produced molecules and nuclides do not increase systematically in the atmosphere, the oceans, the soil or other parts of nature; e.g. NOx (leads to smog, acid rain) and CFCs; (3)... degradation by physical means. This means that the area, thickness and quality of soils, the availability of fresh water, the biodiversity, and other aspects of biological productivity and resilience, are not systematically deteriorated by mismanagement, displacement or other forms of physical manipulation; e.g. over-harvesting of forests and over-fishing.
>
> In a sustainable society people are not subject to structural obstacles to ... (4)... health. This means that people are not exposed to social conditions that systematically undermine their possibilities to avoid injury and illness; physically, mentally or emotionally; e.g. dangerous working conditions or insufficient rest from work;

> (5)… influence. This means that people are not systematically hindered from participating in shaping the social systems they are part of; e.g. by suppression of free speech or neglect of opinions; (6)… competence. This means that people are not systematically hindered from learning and developing competence individually and together; e.g. by obstacles for education or insufficient possibilities for personal development; (7)… impartiality, This means that people are not systematically exposed to partial treatment; e.g. by discrimination or unfair selection to job positions;
>
> nor (8)… meaning-making. This means that people are not systematically hindered from creating individual meaning and co-creating common meaning; e.g. by suppression of cultural expression or obstacles to co-creation of purposeful conditions. (pages 41-43)

Trust, diversity, self-organisation and common meaning are also described as the foundation for social sustainability that counts for all the principles. Expanding the time horizon is also a premise for understanding and interfering with systems for sustainability (Commoner, 1971; Meadows, 2008). Connecting this to time, in the long-, mid-and short-term, the strategies of change may be chosen as stepwise interventions; however, general systems theory (Bertalanffy, 1973) points to the importance of instantly composing the total parts using their interrelation to conceive of the system and its minimum required functions. This also implies a hierarchy that structures a larger, self-organised system. For the wood-based value chain, this implies simultaneously evolving the value chain as a whole.

Delays in forestry systems, as well as in the industry and systems for the use of wooden products, may easily lead to interventions with unwanted overshoots, oscillations and collapse (Meadows 2008). In the context of forestry and the use of wood, design for time has this dimension of delays related to processes in nature—the time a tree requires to grow—as well as the knowledge and skills that make good use of this valuable raw material for long-lasting products and buildings or short-lived consumption products, replacing fossil-based materials and solutions as such. Investment in the industry will always be a risk-taking activity that includes the uncertainty of future market demands and society's opinions that affect political

decision-making, defining national and local frameworks and support for innovation and production volumes. However, a massive global and national push for sustainable solutions should help find a route for values and goals in systemic design approaches for the 'wooden' value chains. Finally, equal distribution is a criterion for social and ecological sustainability, according to Meadows (Lecture, 1999). This applies to a decrease in goods by a large number of people globally, considering that the total ecological footprint has been higher than the earth can regenerate for many years (IPCC, 2022).

Intervening for changes in values and structures in coastal forestry

As a case study, a four-year innovation project carried out by the author on behalf of the Norwegian Coastal Forestry evaluated possible interventions in this intersectoral area. Systemic design is a transdisciplinary practice in which systems theory, as well as cybernetics, scenario methodology, giga-mapping and design methodology, are some of the ingredients and foundation. Design as a discipline has evolved; it still embraces physical products but also services, organisational development and transformation of social structures and sub-cultures (Jones, 2020). Co-design processes are crucial to a systemic design approach, understanding the actor perspectives as well as the social complexity of designing new concepts and solutions. However, a challenge in co-designing is how to include the appropriate parties, create ownership and provide exact and sufficient knowledge to the stakeholders of the development of new solutions. The innovation project sought to mobilise various stakeholders for new types of cooperation and connections through the value chain. The culture of innovation and development along the coast and in the forestry industry has strong roots and historical importance; however, they belong, to a large degree, to previous generations. Today, more voices are asking: Can facilitation and design management for change be readdressed with models from design thinking?

The experiences so far are that a design approach on such a complex level, involving cultural development and transformation of the structures of business, should be supported by more methods and guidance than a rather superficial approach, such as the often-used design approach Double Diamond (2004) and design thinking facilitation

(often led by non-designers). The challenges of forestry might be described as a Wicked problem (Rittel & Webber, 1973). A wicked problem is characterised by no clear owners of the 'problem', neither a clear single solution nor answers. The social complexity of culture and traditions has a foundation in the structure of the sector, with innumerable layers. Design thinking is a design management tool (British Design Council, 2004), and without having a deeper understanding of the context complexity or the participants and their views of perspective and values, fragmentation has been predicted to occur (Conklin, 2005). Table 1 details the simplified division between systemic design and design thinking approaches.

Table 1. Simplified comparison of differences between systemic design and design thinking approach.

Systemic design (Meadows, 2008; Wigum & Gulden, 2021)	**Design thinking (British Design Council, 2004)**
Entering the systems, what is? • Finding the beat of the system • Adding pieces of insight to the understanding of the system • (Play) probing to intervene for a greater understanding of relations and possible leverage points (deeper down in the structures) Where to go • Discover emerging connections, challenges (patterns, traps) and leverage points for interventions • Simulating strategies for intervention testing (opportunities) How to get there • Evaluating intervention choices • Monitoring interventions through implementation	Opening perspectives • Insight—mapping network, user context and existing solutions, defining the problem Converging the scene of the operation • Defining the area and criteria for idea generation and new concepts Opening the areas of solutions • Idea generation—testing and choice of solution Converging and finalising a solution • Detailing concept/service/product • Implementation/production

The Coastal Forestry mobilisation project increased activity for new value chains for the use of local timber resources. The project was related to national networks focusing on tall wooden buildings and the need for competence and experience in the building industry for wood in taller public as well as private buildings. National networks initially focused on the use of wood, not local production and forestry. This has been an explicit choice of a political strategy aiming to increase market demand and then follow up by strengthening the local value chains of local (Norwegian) production of solid wood elements. The next step, relating the sector in total to a circular local economy, calls for a deeper transition. The iceberg model, introduced in system change practice (Stroh, 2015), defines events and single activities as responses to or symptoms of archetype patterns or structures in the system that produce certain behaviours. Below these structures are the goals and mental models (paradigms) of the system (Stroh, 2015). A deeper transition requires, therefore, interventions deep below the event activities.

Discovering systemic traps as leverage points and opportunities

From systems theory (Bertalanffy, 1973; Meadows, 2008), the character or behaviour of a system is known by understanding the relationship between the elements of the system. Exploring the borders of the system as such and the interrelation between systems, as we see them as separate, such as forestry and digitalisation of news or mining, are important. The 'playground' of the defined system may one day be totally changed, and by never lifting the view from the ground, this may come as a total surprise to stakeholders (Meadows, 2008). There are at least three system traps revealed in the Norwegian political and public discussion: the tragedy of the commons, shifting the burden and drifting to low performance (Feil! Fant ikke referansekilden.). There may also be a tendency of success for the successful. System theory points to archetypes of troublesome systems. These lead to certain patterns such as addiction, drift to low performance and escalation. The system of political and administrative structures in Norway that support and strengthen forestry declined at the beginning of the 1990s and continues today. The number of sawmills and wood-based industries has decreased, and pupil and student recruits in wood-related studies reached a severely low state a few years ago. The system may be evaluated as drifting to low performance. After strong pressure from a few 'champions' of the forestry industry (individuals taking

the lead), the government introduced initiatives to interrupt this downhill development. The forestry industry has tried to adapt to the demand for a more efficient approach to harvesting timber, although there might seem to be no higher common goals in the system. However, a national report about wood resources in Norway, Skog 22 (Forest 22), provided the sector with lofty goals and a clear vision. The forestry and wood-based industries in Norway are valued as important parts of the Green Shift. Investments in the wood and timber industries at the moment are rather invisible in Norway compared to its neighbours, Sweden and Finland. Between 2015–2019, Sweden planned to invest 20 billion kroner (1.8 billion Euro), Finland 27 billion kroner (2.43 billion Euro) and Norway 0.3 billion Norwegian kroner (0.027 billion Euro) in new industrial plant and production technology (Norwegian Forest Owners' Association, 2016). The gap in Norway is enormous, from being a threatened industry from the inside and outside, to take an important role in Norway's future economy.

The leverage point with the third-highest impact on Meadow's list is changing the goal of the system or what we want the system to produce. This is part of the value-based qualities of the system, and interventions on this level have the largest impact on change.

The goal of Skog 22, the official national forestry report, is for the value chain from forest to wooden products to play an essential role in the Norwegian economy and increase its economic growth by a factor of four by 2040. The material input (harvesting), however, is only estimated to increase by a maximum of 50% in an attempt to maintain resilient and regenerative forests. The hidden equation seems obvious from this. The goal of value must move from quantity to quality in production as well as forestry. It is expected that the value chain will earn double the price per unit of wood. The added value must be found. The industry must wish to be mobilised in this direction, but it is unclear how to get there.

Table 2. Exploring system traps in relation to promising leverage points in the value chain.

Most relevant system traps for forestry and the local value chain	**Archetype, character of system behaviour**	**Promising leverage points**
'The tragedy of the commons' Too weak or very delayed feedback loops responding to misuse (or no use) of important common resources	Caused by escalation or just simple growth in a commonly shared, erodible environment (resources)	8. Balancing feedback loops 7. Reinforcing feedback loops 6. Information flows 5. Rules 4. Self-organisation
'Shifting the Burden to the Intervenor' Short-term relieving feedback loops	The system is producing addiction or dependencies and is in a state that will not last; this is caused by one large market decline (paper), cost escalation and the subsidy addiction of the foresters	3. Change of goal and purpose of the system 2. Change of paradigms and mindset 1. Transcending paradigms
'Drifting to low performance' Weakening feedback loops or destruction/decoupling of system structure	The actors believe things are worse than they really are and expect less 'Eroding goals' lead to eroding quality of service, expectations or systems	7. Reinforcing feedback loops 6. Information flows 3. Keeping standard goals Making goals align with the best performance
'Success to the successful' Reinforcing feedback loops strengthen the winner and weaken the loser	The winner receives an award improving the possibilities to win again; the losers continue losing	12. Numbers – constants 11. Buffers 10. Stock and flow structures 9. Delays

So far, among numerous approaches for mobilisation for innovation in Coastal Forestry, the most successful approach seem to be the establishment of a seminar concept called 'The value of wood' (Norwegian: Verdien av tre). Stakeholders from the entire value chain are invited both as speakers and as participants to become familiar with the different needs and ways of working along the value chain. The interdisciplinary 'value-chain-set up' has led to transdisciplinary cooperation between foresters, the wood industry and end-users of local materials and products. The leverage point of this concept may be understood by strengthening and innovating new information flow loops. This may also influence the structure of self-organisation, meaning the initiative and further development emerges from within, without outer influence.

Discussion

This article introduces the traps and opportunities along with Meadows' 12 leverage points (Meadows 2008, pages 145-165) for increased awareness of the complexity of the forestry and wood-based industry, as well as how delays and long-term system behavioural patterns are both traps and opportunities to intervene in the archetype of the structure of forestry. However, a surprise to many stakeholders is the role social systems and information flow play in creating sustainable value chains in this sector. Design and intervention for transition require an awareness of the role of values in defining the purpose and goals of the system. The communication and sharing of competence and influence between stakeholders strengthen and create new feedback loops, understanding how quality markets might develop and become resilient. New possible playgrounds (system boundaries) can be discovered through a systemic approach to regenerative and resilient systems. Finally, the transition requires co-design for ownership and the implementation of new concept solutions. Establishing networks, reaching from foresters to architects, designers and engineers for high-end products, is an intervention that may spark a paradigm shift. The second leverage point of the highest influence is the change of paradigm.

The understanding of the nthropocene and the impact human activity has on the earth's global ecosystem is described thoroughly in IPCC reports over the last five years. There may currently be a tipping point regarding the number of people who are aware of these facts; however, a behaviour change seems to be restricted in the existing social

and economic systems. Feedback loops and reinforcement loops steer consumption and monetary escalation at an exponential rate, which is naturally followed by collapse. Lock-ins and rebound effects are well known in the theory of industrial ecology and design for sustainability. However, an overall systemic approach and change in paradigm are required to hinder the treatment of symptoms rather than the root cause of the problems. System dynamics point to the threat of setting exponential economic growth as a goal for the larger system and also the opportunities of being aware of the influence of strengthening relations and connections among functions and elements(as stakeholders) in the system.

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