The following text was written several years ago as the introductory chapter of a doctoral research proposal. While the proposal itself was never pursued further, many of the questions it addresses remain relevant today. At the time of writing, unusually high North Atlantic sea temperatures had become a matter of concern. As these developments once again return to public attention, it seems worthwhile to make this text accessible in its original form. In revisiting it now, and in relation to experiences yet to come, some of the questions raised may become operative and thus prove valuable.

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INHABITING RADICAL CHANGE

Material Engagement & the Rendering-Navigable of Tipping Dynamics in Complex Systems

INTRODUCTION

We see that the world is changing, that stabilities are shifting. We may come up with models and simulations of the future, but in fact we simply can not know how exactly this ongoing transformation will proceed or which path it will take. We are living in times of high uncertainty.

While many are in fear of what may come, are petrified of the negative outlook. some yearn back to supposedly better times of pristine nature, trying to hold on to a state of the earth that has already passed.

But change is happening. And we as humans are not external to this change, we are not only affected by it but have now even become its primary driving force. We don't yet know how to deal with this role – not only responsible for how we got here, but also for how things continue. It may seem strange but we somehow need to find comfort in this ongoing transformation of the planet. We can't just make it stop, so we need to inhabit the change – we need to learn how to navigate it.

It is well-known that we are currently experiencing the transition to a new climatological phase – and some of those more and more frequently mentioned *tipping points* appear to be reached even earlier than expected.

Also, there are legitimate concerns that one of these tipping events is triggering another – and yet another. In this context of such a self-perpetuating accelerating momentum, we usually speak of cascading-, and sometimes also more casually of domino-effects.

However, the matter of tipping points became a major topic – and indeed, this concept does give us an illustrative but proper idea of how radical and far-reaching the processes we initiate can actually be. The use and acceptance of the concept is so widespread that the language of tipping points is now even entering the realm of policy making – which is indeed encouraging in view of the equally far-reaching political adjustments required to adequately meet these changes.

It is almost certain that this topic will accompany us throughout the next decades. Nevertheless, despite the growing presence in public discourse, it is sobering to realize that the actual level of knowledge about these dynamics is still very limited – and from today's perspective simply insufficient.

However, this is hardly surprising, as we are dealing with a high degree of complexity, since for example, the so-called *earth system* tipping points are closely intertwined with people's changing behavior – which is just as difficult to grasp and even more difficult to predict. Moreover, environmental changes can also trigger *social* tipping points – which doesn't make things any easier.

BEYOND THE BINARY

It seems as if we are often confused whether we should dominate our environment or if we are defencelessly at its mercy. But just as we must leave behind old paradigms of absolute control, seeking to subjugate nature and tame the entirety of our material surroundings, we also shouldn't be fatalist, as if we couldn't do anything about what is happening. We are indeed a constitutive part of this world, we do have an impact, we have the rudder in our hands – the question now is how to handle it.

There is indeed an urgent need to better understand the nature of such tipping dynamics. But similar to what was mentioned before, we also should not be oversimplifying this image, we shouldn't be too reductionist regarding this very matter at stake.

Notably, if we look at the measures currently discussed, there seem to be only two ways of approaching the topic. Also here, we are torn between preventative, and again, rather fatalist perspectives – oscillating between prophylaxis – meaning, either work against it or do as little wrong as possible – and on the other hand, dealing with impact governance for reducing the negative effects in case the inevitable does occur after all.

The discourse too often circles around the question whether or not we really reach those points. However, we need also other ways of approaching the topic – and there are indeed alternatives. But as long as we only focus on the before and the after, the exact phase transition remains rather obscure and inaccessible. It may first sound a bit dubious as well, but it is indeed possible to also develop a sensitivity for that very point in-between. We should take a closer look - is it perhaps not really a point? In other words, instead of linking our knowledge production mainly to the question of whether or not we reach these situations, it could be worthy to also gain insights that are not anchored in such a binary thought. This simplification – yes or no – does in fact not meet the actual nature of the true complexities we find ourselves in.

For instance, not only is every tipping situation different and has its very own dynamic character. Also, it is precisely at those exact transitional points that we find a state of delicate balance, meaning that here in particular, even the smallest influence has a major impact. Accordingly, it is especially *while* tipping over, that our utmost attentiveness is required. To put it bluntly, one could say that it is the clumsiness at this very point which is the true fatal element. On the other hand, it is also precisely here that with a sensitive hand, with the right touch, sometimes remarkable things can be done.

With reference to the prior encountering of such tipping dynamics in earlier sculptural investigations, there are even cases in which – through navigational finesse – a system can, instead of sliding over into the other valley, even veer off and move into a new state of metastability. In other words, although reaching the supposed tipping point, the system does actually not tip at all. Instead, the very transitional high point is being *inhabited*, is being widened – unlocking a new niche that was not yet apparent while approaching.

As an Image – an analogy – one could simply think of climbing a mountain. Now, *staying* in the prevailing binary conception is, as if you would *run up* that slope – and *all* you care for is whether you *fall down* the other side of the mountain or not. This, without actually knowing the other side of the hill, without knowing what the topography of this very mountain formation actually looks like. Indeed, at first one may not know the very character of this mountain's crest line – but the closer we get to the tip, or to the ridge, the more we see of that very transition. And just as during the very tipping our senses need to be most attentive, also in this mountain analogy it is at exactly the tip, or the ridge, that one's movement is the most delicate. The smallest steps can be decisive. We are sensing the ground, looking down the other side. Maybe it's not just one ridge but there are three or more ridges joining together – a climax

connecting several valleys, providing not only one but various paths that can be chosen. And it is at this very highpoint at which the decision is made which way to continue. Or - as analogy to what was outlined above – maybe this point of transition turns out to be not just a simple ridge – but a saddle formation. Now, we could either go down the other valley, or instead, with the right turn, simply keep going up on one of the sides – without descending, without any tipping at all.

Indeed, potential tipping points can coincide with bifurcations, points of decision. Also herein lies our agency – and it would be unwise to ignore this. And think, situating oneself at the tip of this transition, one can even think of willingly carving a path, of laying tracks to guarantee a more secure travel, a stable passage. Indeed, what we are considering here is a form of landscape architecture – through our very engagement in the plasticity of *stability landscapes*.

BEHAVIORAL UNDERSTANDINGS

As those elaborations show, our sensorial, as well as our behavioral capacity is a defining factor when it comes to navigating such radical changes. This also means that we shouldn't make our progress dependent solely on explicit forms of knowledge. In fact, the *gaps* in our knowledge regarding the dynamics at stake can not be all filled by traditional scientific methods. One can not learn how to navigate by only analyzing things from the outside – navigation requires systemic understandings from *within* – savoir-faire.

Data-driven research is indeed good for monitoring change, but these numbers don’t really give us the means how to act, they cannot provide a bodily understanding of the matter at stake. We see a current example of this in the alarmingly high temperatures of the North Atlantic last year. The measured values have left attentive observers astonished – and even experts are puzzled. The thing now is, that we may conceptually understand the significance of these numbers – but for our sensory system all those curves that got viral are not much more than any other graphical element – another visual impression. Indeed, to really get a feeling for change, we need to *experience* it.

A little exaggerated, one could go as far as to say that, in a way, our hardships in grasping complex dynamics don’t really come from a lack of navigability – but result from the insufficiencies of our conceptions. Our well practiced sensorial apparatus *does know* how to deal with complexities – and we all have an intrinsic capacity to access and navigate their dynamics. And due to the fact that there is this very behavioral component in the understandings we need to obtain – we simply cannot afford to exclude this potential.

Along these lines, one key for *rendering navigable* the subtleties of tipping dynamics is certainly to also include different forms of knowledge production – and the benefit of incorporating artistic processes into this endeavor is equally apparent.

ANY SUFFICIENTLY COMPLEX SYSTEM

One important aspect for the framework of this inquiry is the fact that any sufficiently complex system that has alternative stable states usually also has tipping points. We can observe such dynamics in various fields – and many of the terms and concepts used for studying these phenomena are indeed also used across various disciplines. Therefore, insights in the dynamics of one of those areas do not essentially need to be bound to this very domain – but can spill over, providing qualitative contributions to understanding also the dynamics of other fields of study.

Now, both social and earth system tipping points have already been mentioned above – but the potential of finding and linking these similar characteristics in very different domains is going far beyond a differentiation of physics and sociology. In fact, we all encounter – and maneuver – *countless* tipping dynamics every day. However, in the context of this inquiry, the most crucial thing is that such tipping behaviors especially also emerge through the exploratory engagement with various material systems.

Notably, the matter at stake does refer to the wider field of studying complex adaptive systems. Also, if we take a closer look, we are indeed operating within the aforementioned framework of *stability landscapes*.

In fact, this mountain analogy was actually not too far off after all. For example, the so-called *ball-and-valley diagrams* are the most common way to visualize situations in which a system can switch between various stable states. The dynamics at stake take the form of valleys - local minima - which are separated by energy barriers in between. However, alongside this notion of tipping points, there are also other concepts – from our standard vocabulary – that can be identified in this very framework. For example, the term *resilience* refers to the specific width of such valleys – or to the effort required to move away from the prevailing basin.

Importantly, there is a certain variety and various degrees of how far and how detailed those depictions seek to describe a system's actual dynamics. There are these simple 2D-graphics showing two or more consecutive valleys – sometimes also aligned as cascades. Then there are extended 2D-versions with an additional time axis – showing also the time evolution of that very wave function. But Indeed, as indicated in the mountain analogy above, it is most of the time a simplification to only think of two or more serial basins with separating energy barriers, each peaking at one (tipping) point. Often, it is more accurate to really think of spatial landscapes – and so there are also 3D-depiction showing a wide field of hills and valleys, ridges, peaks and sinks, providing a big variety of pathways, of transitions from one location of the landscape to another. And yes – as the example of Cyclooctane shows – also more complex stability landscapes can be cartographically represented in such a manner.

For the sculptural practice which is applied in this line of research, it is not without significance that also such conformational dynamics of molecular arrangements can be grasped with such a framework. From rather simple molecular rings all the way to protein foldings and the functionality of enzymes – they are, in principle, all based on the same dynamics. Enzymatic functionalities – for example – refer to specific sets of pathways in these very landscapes. Notably, the by far most astounding insight in this regard was that *novel* enzyme functions are in fact whole *new trajectories* – which can suddenly become viable through very small changes in the underlying structure. In other words: new solutions do not need a lineage.

However, it is for a good reason that this is explained here. In various ways, these molecular arrangements happen to be very similar to the very artistic medium which also this inquiry is building up on. The sculptural investigations in question have indeed never circled around specific shapes but always explored material arrangements in regard to their transformations. Thereby, especially during the first years of this artistic practice, it was hard to grasp the steadily growing corpus of findings that these open experiments brought to light – mainly due to a lack of suitable language and understandings in the realm of architecture and civil engineering. Only after getting in touch with a group of molecular biologists, these gaps could be closed. And it was from that time on, that a number of terms and concepts – also the framework of stability landscapes – have been introduced into the very realm of these artistic explorations. Until now, years later, these insights remain a constitutive factor – while the scope of these extensive studies continues to be widened – both conceptually and structurally.

NAVIGATING UNCERTAINTY

And of course, in the myriad of dynamics encountered over the past 10+ years of exploratory sculptural practice, also countless tipping behaviors emerged. But as a matter of fact, these characteristics have always been a rather implicit part of the experiments. Also conceptually, they somehow always remained a rather peripheral element of thought. However, now, with all those structural insights – and a growing realm of tipping point studies – it becomes apparent that even transformations of our earth system could, in principle, be investigated through the very lens of this artistic medium.

In fact, especially stability landscapes have already become a personal way of understanding very different parts of this world. The matter at stake is thereby merely an abstract, cartesian thing – For example, structural conceptions can materialize – but it is also the very material findings which are shaping the underlying understanding. And just as stability landscapes turned out to be a material language, all those sculptural manifestations are indeed also valuable epistemic instruments.

One of the most important aspects here is that – just as our environment as well as society can not be adequately explored from the outside – also these objects and their stability landscapes are being met from within – by performatively engaging with the specific force relations of the material arrangement. Hence, the performer – or the visitor – is indeed not external to the sculpture, but represents a constitutive factor.

It is in this regard, that also the nature of tipping points can be studied from within – by haptically engaging in dynamics of sudden change – not for the sake of seeking absolute control, but for meeting the unknown – for learning to welcome and strategically implement whatever may come behind the horizon – not for erasing but for navigating uncertainty.

Given the outlined prior investigations, it is out of question that tipping dynamics can be directly studied through material engagement – and that thereby structural as well as experiential understandings can be acquired. However, one should not make the mistake of drawing conclusions all too quickly from one's own area to others. As mentioned before, every tipping dynamic is different – and naturally, also every field in which these dynamics occur is different as well. Notably, it is from the very own perspective – and related to this very field of engagement – that all this potential seems evident. But it is yet to be proven if these insights can be put into a more general perspective, if it is really feasible to artistically explore the very nature of tipping dynamics as such.

From a formative perspective, it is the specific methodological approach which is decisive in this question – namely, the fine adjustment of how one's own studies are strategically interwoven with the views of others. Essentially, shared knowledge is always a matter of discourse and information transfer – and most especially of new understandings genuinely arising at the very junction of various perspectives.

Back to an individual standpoint, down to the very content layer of the inquiry at hand, the topic of tipping behaviors has never been tackled frontally – there have been no investigations stating this intention – and even less so in the perspective of communicating such insights to others. Whatever may have tangented these questions has never been formalized and put into a coherent and accessible framework that can be part of a wider public discourse. It would well remain of purely individual relevance, but potentially never surfacing from these depths – a pity, not just for the topic itself.

But now there is clearly an urgency in the matter - and this makes it an issue of responsibility. Also, as mentioned above, there is a general sensibility about the topic today. However, it is precisely this coming together – a major socio-environmental crisis – and an opportunity to provide a valuable contribution to mastering this challenge – it is this coincidence, which constitutes and defines the starting point of this project.