Criterial Time vs. Impact Time: Entraining Timescales in the Governance of Endocrine-Disrupting Chemicals

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Abstract

Endocrine-disrupting chemicals (EDCs) and the attempts to regulate these have lately received considerable political and scholarly attention. The temporal dimension – the inherent time lags of EDC governance – has been particularly troublesome, as the chemicals challenge existing timescales of regulation. In this paper we investigate this temporal dimension by analysing the temporal orientations of regulators and scientists in the European chemicals regulatory system. Our findings show that two conflicting timescales can be identified: criterial time, as represented by the regulators, and impact time, as accessed by the scientists. In this paper we present a solution which encourages entrainment, or synchronisation, of the timescales. We do this by highlighting the notions of practices and phronetic institutional entrepreneurship and argue that these components are crucial in the process of integrating the timescales. The paper concludes that greater attention towards the multiplicity of timescales is required and endeavors to integrate these timescales need to be situated in the institutional context.

1. Introduction

Since the early 1990s, the topic of so-called endocrine disrupting chemicals (EDCs), or substances that interfere with the hormonal systems of living beings in an adverse way, has been on the political agenda of most industrialized countries (e.g., Hecker and Hollert 2010; Krimsky 2000; Vogel 2004). However, despite a deeply felt concern regulatory communities worldwide have been slow to incorporate the chemicals posing endocrine concerns into existing legislations (Hecker and Hollert 2010; Vogel 2004). This paper addresses the temporal mismatch between observed adverse hormonal impacts and delayed regulatory action, and asks: 1) What are the main causes behind this temporal lag? 2) How can it be remedied?; and 3) Can an explicit focus on time and the nuances of temporal phenomena such as, e.g., rhythms, paces, and time norms aid in finding ways to speed up the current worrisome development trend?

Despite the ubiquity of serious environmental issues manifesting the kind of temporal mismatch evidenced in the case of EDCs, surprisingly few environmental policy analysts have dealt with the issue of temporaly head-on (see, e.g., Ascher 2006). According to Adam (1995, 2003), temporal mismatches such as the one observed with EDCs highlight that 'the time-frame of the perceived danger is out of sync with the time-frame for action' (Adam 1995: 132). Within the field of science and technology studies, oriented towards studying especially various kinds of time-related practices, Karasti, Baker and Millerand (2010) have identified two distinct 'temporal orientations' in information infrastructure development work in the domain of long-term ecological research, or LTER, namely 'infrastructure time' and 'project time'. The notion of (research) 'infrastructure' within long-term ecological research, they suggest, would benefit greatly from explicitly recognizing the two distinct orientations and the tensions between them.

In this paper, we build on the temporal analyses found within environmental social science as well as in science and technology studies to build an argument to the effect that the more specific form or shape taken by the current temporal endocrine-related misfit (Adam) between the man-made instititutions of especially the science-based regulatory infrastructures (Karasti et al.) of the new European chemical regulation and the parts of ecosystems relating to hormonal activity, is one between what we call institutional criterial time and hormonal impact time. Performing such an analysis, we argue, opens up possibilities for finding new and innovative ways in which these two currently mismatched temporal orientations can be entrained (Ancona et al. 2001), or synchronized with regard to central temporal phenomena such as, e.g., pace, rhythm and cycles.

In addition to the notions of institutional criteria time and hormonal impact time, we highlight the notion of 'practice time', as presented in the everyday experiences and behaviour of individuals, as a valuable part of EDC governance. In this paper we argue that the basis for achieving entrainment

of these three timescales in the EDC governance system is phronetic institutional entrepreneurship – the process in which the timeframes of policies and practices are integrated. Phronetic institutional entrepreneurship thus highlights the need for recognising various temporal conceptions and the institutional setting in which entrainment takes place.

The work presented in this article is based on empirical data on EDCs gathered by the first author in 2010-2012. Interviews were conducted with Finnish (n=15), Danish (n=7) and US (n=6) EDC experts and decision-makers. The first author also participated in three Nordic Workshops on EDCs held in Copenhagen in 2010. The semi-structured interviews as well as the workshops were transcribed in their entirety. Secondary literature on the history and policy challenges of EDC was collected and analyzed, as was a large number of natural scientific review articles. As to the actual processes of classification and analysis, our focus on temporality led us to systematically look for, extract and compare references to time (e.g., representations of time, pace, cycles, rhythms etc.) from the documentary, interview and workshop material.

The paper is structured as follows. In the next section, we briefly outline the ways in which time and temporal phenomena have been adressed in the two literatures of environmental social science and science and technology studies (STS). In the third and fourth sections, we present the basic elements of the empirical setting in which the EDC-related temporal mismatch plays out, as well as outline the central varities of time of relevance for the temporal misfit under study. In the discussion, we suggest new ways in which our analysis can lead to new and less mismatched entrainments between institutional and ecosystem times. We end by summarizing our results.

2. Theoretical background

2.1 Environmental governance and institutions

Institutions are generally conceived as 'any form of constraint that human beings devise to shape human interaction' and can be either 'formal' or 'informal' (North 1990: 4). In this paper we treat institutions in a somewhat narrow sense – we are interested in the ways in which regulation of EDCs is temporally situated. The reason for treating time and more specifically speed of environmental regulation seriously is that there is a general agreement institutions in society change slowly and tend to resist quick changes (Zucker 1987: 446; March and Olsen 1989; Mahoney and Thelen 2010). This institutional inertia emphasises that institutions thus change gradually over time and by doing this they bring about stability and structure to human life. Indeed, a characteristic of an institution is that it is at least to a significant extent stable. The problem arises when the institution is ill-defined or temporally misplaced and thereby generates, in this case, challenges of protecting environmental and human health.

The notion of institutional stability and the deterministic influence of institutions on human behaviour have, however, lately been contested. The scholarship on institutional entrepreneurship (IE) can offer valuable insights into the interplay between institutios and human agency and more specifically how actors behave "inside" institutions (e.g. Leca et al. 2008; Hardy and Maguire 2008). This approach proves valuable for studying how actors understand the institutions of the EDC governance system and how they act in order to influence these institutions. On a general level, IE refers to the acts of 'organized actors with sufficient resources (institutional entrepreneurs) who see in them an opportunity to realize an interest that they value highly' (DiMaggio 1988: 14). Others have emphasised the role of actors in engaging with other actors in change processes (Fligstein 1997) and the strategic skills of individuals in visualizing different pathways within a specific institutional setting (Beckert 1999).

The focus on agency within institutional settings becomes increasingly important bearing in mind the environmental challenges and totality of interconnected elements in socio-ecological systems (Voß and Kemp 2006: 10-14). To respond to these threats, the "traditional" forms of environmental regulation emphasising formal means of control has been under severe criticism. A development from 'government' to 'governance' (Stoker 1998) has entailed the introduction of a variety of voluntary, market-based and informational tools (Jordan et al. 2005). However, the notion of governance does not imply that the role of the state within environmental regulation has vanished; rather it implies that the role has changed (e.g. Bell and Hindmoor 2012). In this paper, governance refers to the complex relationships between policy, science and practices, while emphasising the need for co-ordinating and streamlining each sphere in a timely fashion.

2.2 Practice-oriented science and technology studies and temporality

As argued by Karasti, Baker and Millerand (2010: 383), our common sense view of temporal scales relates to durations of time, such as, e.g., lunch hours, work days, and funding periods. Temporal scales have received much attention also in the academic literature on time (e.g., Adam 1990; 1995; 2003), where a distinction between objective and subjective times has been made. The objective view presents time as referring to absolute, quantitative size temporal intervals independent of human action (Zaheer et al. 1999; Karasti et al. 2010), while the subjective view holds that temporal scales are socially constructed, contextual, and relative to people's norms, beliefs, and customs (e.g., Adam 1990; Karasti et al. 2010). The stance gradually growing stronger is one that stresses the necessity of attending to both structural/objective and interpretive/subjective aspects of temporal order (Karasti et al. 2010; Orlikowski and Yates 2002).

Karasti et al. (2010: 383-384) stress that temporal scales are 1) diverse; in addition to temporal scales relating to human/social systems, they can be dependent on other 'actors' such as those relative to nature's time or ecosystem change; built environments and technologies such as railroads

and digital/IT systems; 2) situated, or pertaining to particular settings; thus, to be able to understand what temporal scales are meaningful in a particular social context, one needs to study the everyday practices of participants with what Ancona et al. (2001) call a 'temporal lens; and 3) relational; temporal scales vary, for instance, for different participants in some specific process (e.g., the company executives and research biologists in a biotechnology company context).

Based on his research on biotechnology industries, Dubinskas (1988) also makes an important distinction between temporal scales and temporal orientations. The two communities of different occupations as professions that Dubinskas identified (the company executives and research biologists) contrasted in terms of temporal scales: whereas the temporal scales for managers could be characterized in terms of short-range plans and closed-frame problem solving, the scientists' temporal scales related to more long-term, open-ended planning and problem solving (Dubinskas 2008; Karasti et al. 2010). Based on these temporal scales, Dubinskas identified the two temporal orientations of 'closed' and 'open-ended', respectively. Thus, temporal orientations are "temporal scales that relate to a group's understanding of meaning and value as well as to their interests, aims and motivation" (Karasti et al. 2010: 384).

Based on this existing work on temporality, Karasti et al. (2010) analyze a case of research infrastructure development within long-term ecological research (LTER) in the US, and identify two distinct temporal orientations associated with such development: 'infrastructure time' and 'project time' (381). "For developers, a project timeframe of approximately three to five years represents long-term, whereas for information managers the long-term relates to an overarching concern for the long-term of ecological science and legacy datasets as well as expectations of data reuse and new technological solutions by future generations" (2010: 401). The work of Karasti et al. thus presents an alternative view to the traditional approach within much work on time and ecology that perceives the temporal of the 'short-term' and the 'long-term' as being in a state of 'tension' (Karasti et al. 2010). Thus, rather than treating the different temporal scales merely as a tension,

Karasti et al. put forward the interplay of the two as a synergistic approach to infrastructure development, as exemplified in the temporal orientation of 'infrastructure time' (381).

Recently, issues of temporalities and especially of rhythms have risen to the fore also within the research on everyday practices and experiences (e.g., Shove, Pantzar and Watson 2012). With regard to human health, one challenge within this research has been formulated as being to learn how individual health disturbances and failures and the reproduction of societal and individual temporalities co-create and co-construct each other (Shove et al. 2012). For instance, it has been suggested that rather than viewing health shortcomings as personal failures they should be seen as results from failed attempts to negotiate temporal orders, i.e., as the inability to alternate successfully between the short-term (e.g., drinking, gambling etc.) and the long-term (reproduction of the social order). Thus, the unsuccessful balancing of temporal orders is not a cause or effect of individual health disorders, but rather the two co-create and support each other.

We propose that the same kind of perspectival change—applying the 'temporal lens' directly on the phenomena under study that has been performed by Ancona et al. (2001), Karasti et al (2010) and Panzar and Shove (2010)—be performed also with regard to the empirical phenomenon of EDCs. In particular, we wish to highlight a notion that has been used by both organizational (Ancona et al.) and practice theorists (Pantzar et al.), that of entrainment or temporal synchronicity, in relation to environmental governance. To this we now turn.

2.3 Linearity and Chaos: A Case for Entrainment?

The idea of temporally aligning governance with ecosystems is not novel. There is currently a wide array of literature on institutional fit (see e.g. Young 2003; 2008; Galaz et al. 2008) that sheds light on how well our human-designed institutions are designed in terms of effectively governing environmental harm on various spatial and temporal scales. For the relevance of this paper, the focus temporal fit of institutions and ecosystems is of central importance. Depending upon the

problem at hand, institutions can be designed to focus on the short or long-term or they can be too quickly or too slowly implemented in relation to the environmental problem (Galaz et al. 2008: 151). Thus, the idea that institutions need to be developed in a temporally sensitive manner emphasises that we cannot take time for granted.

According to Adam (1998: 50), EDCs definitively operate on a multitude of temporal scales. The institutional conceptions of time, however, are more one-dimensional. Adam (2003: 64) sees that the political, scientific and economic realms of industrialised societies share an understanding of time as 'clock time', 'decontextualized', 'quantified', 'linear', 'invariant' and 'external'. These realms thus have one trait in common; they see time as 'moving forwards like an arrow' (Pollitt 2008: 51) that is universally observable and measurable. In terms of the political realm, this conception of time presents severe challenges to dealing with EDCs, as it sidesteps the temporal diversity related to the chemicals. What we are referring to here should not be merely understood as 'political time' as defined as the study of, e.g., electoral cycles (e.g. Ekengren 1998); rather we see it as the more general time-frame of EDC governance.

Furthermore, in terms of the scientific realm, the 'arrow-like' conception of time limits the recognition of temporal diversity, as it 'impose[s] clock time on nature' (Adam 2003: 64). As will be highlighted later on, this scientific understanding of time with its emphasis on quantifiable risk assessments generates significant problems for the regulation of EDCs. The relationship between governance and EDC timescales is depicted in Figure 1.

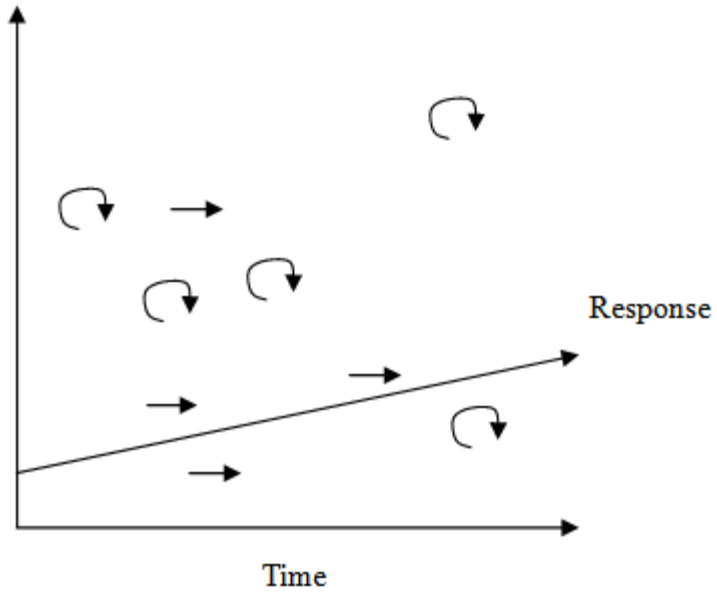

Figure 1. The Temporal Scales of EDC governance (based on Held 2001: 358).

This apparent dissonance between EDCs and governance systems raises one crucial question: How are we able to overcome these temporal misfits? In this paper we put forward the notion of 'entrainment' as a possible solution to this problem. By entrainment we refer to 'adjusting the pace or cycle of one activity to synchronise with that of another' (Ancona et al. 2001: 656). The notion of entrainment stresses the need for accepting temporal diversity and moving on to investigate how this may be taken into account when designing policies related to the regulation of EDCs. Bearing in mind the time-lags and temporal mismatches between EDCs and regulation, there is an urgent need for developing a governance system that is capable of acknowledging and acting upon multifaceted temporalities.

3. Presentation of the empirical setting

The story of EDCs begins in the late 1980s with the groundbreaking work performed by the scientist Theo Colborn. Before Colborn, there was scattered evidence of disturbances in reproductive function due to the use of chemicals among animals as well as humans. Colborn's major achievement was the recognition that all the separate cases had something in common: the

problems they manifested were all caused by a diverse group of industrial and agricultural chemicals with the capacity to mimic and/or obstruct the hormone function of humans and wildlife. In the writings to follow, this key idea was to become known as 'the environmental endocrine hypothesis' (Krimsky 2000).

In the years to follow, social pressure was building in favor of governmental action. Part of this buildup process was the mass market book *Our Stolen Future* (1996), written by Colborn with colleagues. The result was the establishment of the US Endocrine Disrupting Screening Program (EDSP) in 1996, which was to be put in place with a strict timetable of only two years. Things did not turn out the way of ordinary risk assessment, however. The Environmental Protection Agency, which was to take responsibility for implementing the screening process, accomplished only preparatory work on the Endocrine Disruptor Screening Program through 1998, thus failing to meet the first mandate to develop procedures by August 1998 (Vogel 2004).

As of 2012, the process of turning the environmental endocrine hypothesis into a technical test for endocrine disrupting capacity is still very much underway, both in the US and globally. Much of the concern over chemicals with potentially endocrine disrupting properties is channelled into the development of test guidelines for detecting endocrine disruptors by the OECD; the developed guidelines are not, however, designed to be mandatory. Endocrine disruption is also on the political agenda in the EU, where, in 1999, the European Commission adopted a strategy addressing the issue. In principle, EDCs are covered by the REACH authorization process on a case-by-case assessment. However, the lack of a clear definition of and/or criteria for the identification of EDCs has largely prevented making reference to endocrine disruption (Torslov et al. 2011a).

4. Analysis of the empirical case from the point of view of temporality

4.1 Setting the stage

During the last 20 years, the potential threats from endocrine disruptors have been the focus of intense work within the EU, where action is mainly guided by the EC strategy on endocrine disruptors (EC 1999). The strategy specifies several actions to be taken, among them initiatives to further research in the area, international co-operation, and information to the public. Measures with regard to hazard identificiation, risk assessment and risk management include the development and validation of new test and assessment method; these take place at both international (OECD, Community) and national levels (DK 2011).

With regard to temporality, the strategy is divided into short-term, medium-term and long-term measures (EC 1999). Measures pertaining to the long-term arethe development and adaptation of legislative instruments and policy action that enable hazard identification, risk assessment and risk management of EDCs (Hecker and Hollert 2010).

From the point of view of the last one, in the EU, EDCs are dealt with under a wide variety of Community legislations concerning different types of chemicals and serving different regulatory purposes. Under REACH (Reg. (EC) No 1907/2006) general provisions for the safe use of chemicals apply; in addition, however, if a specific substance is identified as a Substance of Very High Concern it can be included under the so-called authorization scheme specifically as an EDC on the basis of a case-by-case assessment (Article 57(f)). Also, the new Plant Products Regulation (PPPR) (Reg. (EC) No 1107/2009) includes approval criteria for substances with endocrine disrupting impacts on human health and the environment.

However, the numerous knowledge gaps, uncertainties and complexities with regard to the ways in which EDCs exert their impacts on living organisms at the time of drafting these legislations led to a delay in the establishment for clear definitions and criteria for for the identification and

management of potential EDCs. Reflecting this limited basic knowledge of EDCs at the time of the adoption of REACH, a review of the authorization procedure with regard to EDCs is required by June 2013. Furthermore, the Commission is mandated to present a draft with scientific criteria for EDCs with impacts on (only) human health by 14 December 2013 (DK 2011).

From a regulatory point of view, however, the process of drafting criteria for EDCs is greatly complicated by the fact that endocrine disruption is not a single mechanism, but relates to many different mechanisms, modes of actions and toxicity pathways. Accordingly, the harmful impacts of EDCs relate not only to reproduction and development, but also to the development of cancer, obesity, diabetes, metabolic syndrome, immune system and brain development (SAA 2011). Furthermore, there is solid evidence that not only the dose but also the timing of the exposure is critically important for the emergence of adverse impacts; if exposure occurs at a critical development window, even a very low dose can have irreversible impacts (SAA 2011).

These complications also place high demands on the drafting of the actual criteria: these should somehow, at the one and the same time, be able to both accommodate for these complexities and allow for identification of EDCs in the existing and recently adopted legislations for chemicals as well as in future ones. Furthermore, despite there being almost insurmountable scientific uncertainties and complexities especially with regard to mixture effects, regulators explicitly require the criteria to be science-based (see, e.g., Vogel 2004). Next, we will look at the suggestions for criteria with a particular view on the different kinds of temporalities they imply.

4.2 Regulators' 'institutional time'

At the time of writing, the main dividing line is between the suggestions for EDC criteria presented by Germany and the UK, on the one hand, and Denmark, on the other. Starting with the the first Final Joint DE-UK position, (hereafter termed DE-UK), the regulatory document begins by stating that an important perspective from which to begin is the recognition that within these pieces of

legislation, the consequences of identification of a substance as an ED of very high regulatory concern is potentially of great commercial impact" (DE-UK: 1). Thus, there is from the beginning a recognition, albeit implicit, of commercial practices of various kinds being of central importance for the issue. The conclusion drawn by this recognition, however, tends towards providing, based on economic considerations only, a set of criteria of what an EDC is that allows for almost no consideration of the ways in which such chemicals pose challenges for the existing toxicological paradigm: "Hence this paper takes the position that the assigning of the ED identifier to a substance should be reserved for those substances where such a property is clearly established, the substance is potent in this respect, and the endocrine-disrupting property is a prominent feature of the hazard profile of the substance" (DE-UK: 1).

The key word here is 'potency'. According to this suggestion for criteria for EDCs, an EDC "should be an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse effects in an intact organism, or its progeny, or (sub)populations", and in so doing satisfies the following four criteria: "1) adverse effects to have been seen in one or more toxicity studies of acceptable quality, in which the substance was administered by a route relevant for human exposure; 2) a plausible mode-of-action/mechanistic link between the toxic effects of concern and endocrine disruption to have been inferred; 3) the effects seen in experimental animals to be judged of potential relevance to human health; and 4) serious adverse effect(s) related to endocrine disruption to have been produced at a dose at or below the relevant guidance value for the application of Category 1 'Specific Target Organ Toxicity-Repeteated Exposure, STOT-RE' classification & labelling" (DE-UK: 8).

If implemented, this definition and these criteria would mean that for all other chemicals than pesticides, which are regulated more strictly also from the point of view of endocrine disruption, although a specific substance would be proven to cause significant adverse in wildlife (other mammals, fish, birds, amphibians, invertebrates), there would be no valid reason whatsoever to

restrict its use in the EU area. Furthermore, since effects can occur at low doses at particularly critical developmental windows also for humans, there is a real possibility that such criteria might also leave regulators helpless even in front of adverse effects on humans.

Of other interested EU countries, especially Denmark has raised serious objections to this classical potency-based suggestion. In contrast to the DE-UK, the very starting point for the Danish position (henceforth DK) is the recognition that the "basic paradigms and tools of toxicology and ecotoxicology seem inappropriate to fully address the issue of endocrine disruption" (DK 2011: 2). Also, in contrast to the DE-UK proposal the DK proposal considers endocrine disrupting properties to be an intrinsic property of a chemical regardless of the area of application, whence the definition should "be appropriate for protection of both human health and the environment"; furthermore, the "same definition should apply for all types of EU legislation and, if possible, the same definition should also apply at the international level" (DK 2011: 3).

Accordingly, both the proposed definition and the criteria reflect these different starting points. For actual EDCs the definition remains the same as in the other proposal, but in addition the DK proposal suggests that the notion of 'potential' EDCs made by the IPCD/WHO in 2002 be divided into two sub-categories—*'suspected' EDCs* and *'indicated' EDCs*, respectively—and incorporated into the revised legislation. Each should reflect the "level of evidence" available. Thus according to this proposition, substances are placed in *Category 1 – Confirmed EDCs* "when they are known to have caused ED mediated adverse effects in humans or animal species living in the environment or where there is evidence from animal studies, possibly supplemented with other information, to provide a strong presumption that the substance has the capacity to cause adverse effects in humans or animals living in the environent"; they are placed in *Category 2a – Suspected EDCs* "when there is some evidence for ED effects from humans or experimental animals, and where the evidence is not sufficiently convincing to place it in category 1"; and they are placed in *Category 2b –*

Indicated ED "when there is some in vitro/in silico evidence indicating a potential for endocrine disruption in intact organisms" (DK 2011: 6)

Table 1. DK-2011 summary.

WHO/IPCS definition	EU definition
ED	Category 1: ED
Potential ED	Category 2a: Suspected ED Category 2b: Indicated ED

Obviously, these different criteria and their eventual implementations implicate very different temporalities for regulatory action with regard to EDCs: it is, for instance, highly likely that the Danish alternative allows for much more rapid policy action. Under especially the latter scenario, the typical time estimates given by EDC researchers and policymakers alike across Europe for having "solved" the problem of EDCs is 5-15 years (interview and workshop data; see also the documentary *Cocktail of chemicals* produced by the Finnish channel YLE5). Hopes are high especially for the latter proposal's capacity to produce criteria that "allow for both screening and final identification of chemicals with endocrine disrupting properties" (DK 2011: 3).

However, a quick glance at existing policy research addressing the speed of such regulatory efforts does not support such optimistic judgments. In the US context, policy analyst Jason Vogel (2004) has documented the statement made by U.S. Congressman Mike Synar, who during a committee hearing on the safety of pesticides is reported to have stated that, "Almost 20,000 pesticide products have been under review since 1972 and only 31 have been reregistered. At this rate it will take us to

the year 15,520 A.D. to complete. I believe in good science. What I don't believe in is geologic time" (U.S. Congress, 1993)."

4.3 Scientists' 'hormonal time'

The latest bid on what science has to offer with regard to EDCs can be found in the *State of the Art Assessment Interim Report* (2012), yields another perspective on time and which paints a worrisome picture of the impacts of EDCs on various kinds of organisms. Reflecting the supremacy of the concern for humans, issues of human impact get much attention and are divided into effects on male and female health, respectively. As for males, the report discusses the so-called *Testicular Dysgenesis Syndrome* (TDS) as identified and described by the Danish researcher Niels Skakkebaek with collegues starting in the 1990s. The TDS hypothesis proposes that the syndrome goes back to diminished androgen action in fetal life, and it also proposes a strong environmental component and and chemical exposure as main etiological factor (SAA 2012). Most importantly, the report points to the identification of the so-called male programming window in rats (which functions as model animal for humans) when fetal testes begin to synthesize testosterone.

As for the impact on female health, the report points to several fetal critical windows of susceptibility for a range of relevant aspects and conditions: female precocious pubertly; female fecundity; female fertility and adverse pregnancy outcomes; polycystic ovaries syndrome; endometriosis; and uterine fibroids (SAA 2012). Furthermore, EDCs and especially exposures to them during development in the womb are implicated in a range of hormonal cancers with regard to both male and female health: breast cancer; prostate cancer; testis cancer; and thyroid cancer, via low birth weight (SAA 2012).

Although characterized by much uncertainty and many significant knowledge gaps, the knowledge that *does* exist on the topic points to the same pattern of critical temporal vulnerabilities as being of high relevance for all wildlife categories addressed in the report (e.g., other mammals, birds,

reptiles, amphibians, fish, and invertebrates); for instance, of fish the report states that early development is more sensitive than adult (2012).

Also, as has been emphasized by recent work on EDCs, geographical differences matter deeply; indeed, it might turn out that whether there are adverse effects to be seen or not depends not only on the specific compounds that are to be found in some particular area, but on the specific mixtures they happen to form as a result of various human practices such as agriculture, industry, consumption patterns etc.

4.4 Temporal orientations of the regulators and the scientists

How, then, do the temporal scales of these two communities—EDC regulators and EDC scientists—look like? As was the case with Dubinskas' (1988) and Karasti et al. 2010), we can also here discern a basic tension between a 'closed' orientation and an 'open-ended' one. The main aim of the actors engaged in developing criteria via work in numerous task and work groups at international and national levels is precisely to achieve closure in order to ensure operationality with regard to the EDC issue, while the temporal orientation of the actors engaged with impacts varies between open-ended (when going for and trying to find new ways of dealing with the numerous complexities involved in such research) and closed (when momentarily laying those results down in scientific articles). Thus, we suggest that the main temporal orientations of the communities involved in addressing the concerns raised by EDCs are 'criterial time' and 'impact time'.

However, despite the recognition both within the regulatory community and the scientific community, it is striking that nowhere in these documents are there any indications as to exactly when (or for that matter, where) those critical windows occur. In other words, both criteria and impacts are addressed at a thoroughly universal level, concentrating on removing all such potentially harmful from everywhere. Yet, as we have seen, there are significant differences

between the mixtures that organisms are exposed to depending on when and where they occur; and we also have good reasons to suspect that such a universalistic approach will take (too) long time.

Thus, in this paper we suggest that a significant aspect of the this problematic is that the reflection on the topic within both communities makes no reference whatsoever to ***'practice time'***, that is, to the highly relevant rhythms and paces of the myriad practices that go into turning the issue of EDCs into a problem in the first place. If addressed at all, it tends to be relegated over to the domains of 'soft regulation' with its emphasis on mainly informational activities. We suggest, however, that practice time is an issue that urgently needs to be incorporated also within the 'hard' regulation. More specifically, we argue that it needs to be connected or entrained to the identified temporal orientations of criterial time and impact time to form the basis of a more flexible regulation capable of dealing with the challenge posed by EDCs. In the next section, we put forward a novel approach to dealing with the temporal challenges relating to EDC governance.

5. Discussion on innovative solutions to the temporal problem

5.1 Policies

From a policy perspective, entrainment can be obtained by favouring the development of organisational infrastructures that support the incorporation of different temporal scales. Focusing on the time-scales within organisational structures can help us understand especially how various temporal rhythms can be anticipated. One way of achieving this could be the separation of organisational units with different temporal scales. Ancona et al. (2001) argues that separating units with quick adaptive capacity and others with an emphasis on continuation (c.f. Karasti et al. 2010), can be a solution to overcome time-lags. Furthermore, Hukkinen (1999) has argued that organizations endowed with long-term sustainability considerations should at the institutional level be separated from those concerned with short-term economic objectives, to enable them to pursue sustainability goals with the necessary autonomy and authority.

In the case of EDCs, the linearity of risk assessment/governance could be challenged by dividing the regime into smaller distinct entities with different temporal objectives – one with a more adaptive, "experimental" or project-like work environment and another that is responsible for the long-term co-ordination of the assessment procedure. The creation of smaller reflexive units could enable work that is stretching beyond institutional and cognitive boundaries. This is turn could allow for the development of quick procedures. However, dividing units according to their temporal objectives needs to be designed so that time-effective feedback loops between the units exist.

5.2 Practices

Since the most vulnerable to the adverse effects of EDCs when human beings are concerned are fetuses and small children, the practices that have drawn most attention from regulators, scientists and NGOs alike are the ones imposing a chemical burden on these. For instance, much work is of all of these is directed towards doing what is possible to minimize the exposure of especially pregnant women and young girls by means of soft regulation. In recent years, the Danish EPA has set up a number of information campaigns to influence consumer behaviour in groups judged to be the most exposed. In 2006, the Danish EPA launched the information campaign "9 good habits" to pregnant mothers (http://www.babykemi.dk/), followed in 2009 by a campaign called "65.000 reasons for better chemistry" directed to parents of toddlers (http://www.netdoktor.dk/65000.htm). Both campaigns aim to target the everyday practices of mothers and other caretakers.

However, although the significance of the both practices described above and the temporalities and rhythms they embody and imply is recognized within the context of soft regulation, there is no attempt whatsoever to incorporate this recognition into 'hard' regulation or the domains of definitions and criteria with their temporal implications. Next, we will briefly present an example of what such an entrainment might look like in practice.

From studies on impacts, we know that the development of fish in, say, the waters outside of the Helsinki metropolitan area is particularly vulnerable to the impacts of EDCs in, say, June and July. However, these two summer months are also the ones when consumption of sunscreens with endocrine disrupting properties peaks. Now, the standard response to the situation is to instigate some kind of information campaign to try to influence consumer use of such sunscreens. Since such campaigns rarely get at the root problem, and endocrine disrupting UV filters are not regulated via the criterial route in any foreseeable future, this non-entrainment of these three temporalities—practice, criteria, and impact—in all probability leads to the smooth continuance of status quo.

However, were these three temporalities to be entrained, the story might go something like this: Worried scientists identify June and July as the most critical impact time for certain ecologically and economically important fish species. An analysis of the chemicals by natural scientists doing the most harm yields UV filters as a central component of the exposure mixture; and an analysis by social scientists yields the practices of mothers to small children as especially prone to use products containing such chemicals, starting immediately when the sun season begins. Now, enter regulation: based on the input provided by natural and social scientists on impact and practice time, a proposal emerges prohibiting placing products containing such specific chemicals on the market during the time period of May-August. Since products containing such chemicals are not available on store and pharmacy shelves during this critical time period, fish exposure to them is reduced.

6.3 Phronetic Institutional Entrepreneurship

Based on the previous reflections, we here put forward the notion of 'phronetic institutional entrepreneurship' as a possible solution for achieving entrainment of these spheres. Phronesis refers to the activity of blending different forms of values and rationalities. This blending occurs "in the moment" and within a specific context, thus stressing the role of immidiate and experience-based reasoning (Flyvbjerg 2001). Placing the notion of phronesis on the individual level, Michael et al.

(2007) argue that persons with phronetic abilities are able to resolve tensions between expert considerations, ethics and policy by acknowledging and accepting their co-existence. Phronesis is also closely related to the concept of pattern recognition, where individuals are able to identify certain sequences and plausible solutions to a particular situation based on previous experience (Honkela et al. submitted). In this paper, we see temporal phronesis as the ability to conceptualise and simultaneously work within various temporal time frames in a governance system.

To situate temporal phronesis in the EDC governance context, we here connect the concept to the scholarship of institutional entrepreneurship. As highlighted earlier, the institutional entrepreneurship literature provides a valuable vantage point for studying the interplay between institutions and human agency. Temporal phronesis and institutional entrepreneurship are interlinked in the governance of EDCs in that they enable novel and overarching strategies to overcome the inherent time lags within EDC governance stemming from conflicting "criteria" and "impact" timescales, as highlighted in the analysis, and by aligning these with "practice" time. Thus, we argue that phronetic institutional entrepreneurship acts as a basis for entrainment. By emphasising temporal phronesis, the individuals involved in the governance system can pinpoint tensions between different time frames (see Figure 2 for a depiction of our argument).

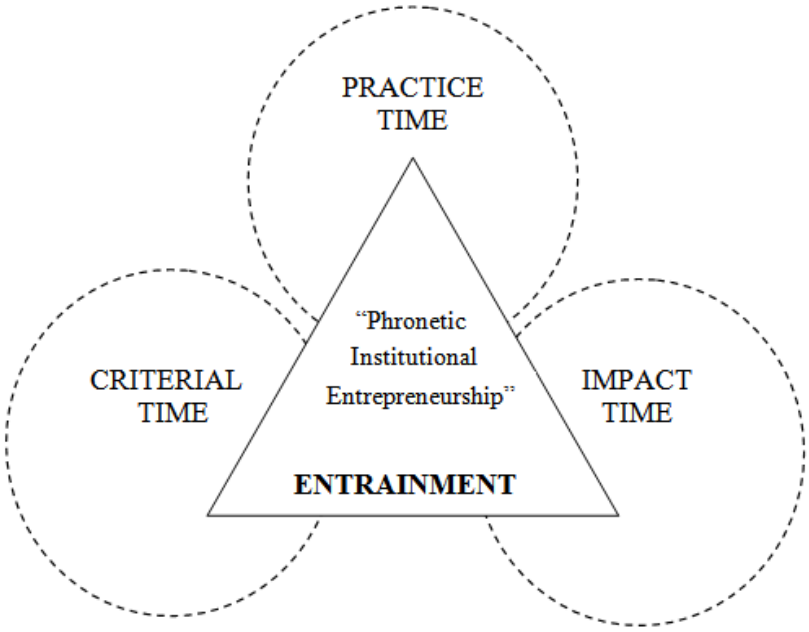

Figure 2. Entrainment of Timescales in the Governance of Endocrine-Disrupting Chemicals.

The ability to make these tensions explicit is a necessary first step. Being able to work within various time frames does not imply favouring a particular conception of time; rather the individual understands the situation holistically as comprised of criterial, impact and practice timescales. For example, recognising similar patterns of EDCs in terms of their structure or effects on human health can offer the alternative routes to establishing regulatory criteria.

Subsequently, as the individual become aware of these temporal tensions and recognises their internal logics, the experts are able to influence the institutions that strengthen the one-dimensional conceptions of time thus prohibiting entrainment of EDC governance and, furthermore, encouraging institutional inertia. In terms of institutional entrepreneurship, the focus needs to be on the ways in which individuals or organisations transfer the practices on the micro-level (the establishment of regulatory criteria) to policy. This requires that the organisational structure is adaptive to innovative everyday practices. By highlighting the role of institutional entrepreneurship, we stress the need for taking endeavours of entrainment seriously and carefully studying the context in which this takes place. The central idea is that institutional entrepreneurship is needed to overcome the existing

institutional discrepancy within EDC governance. In other words, it is insufficient to merely state that entrainment is achievable through functionally aligning temporal cycles – rather, we need to fully appreciate the institutional context and its influence on the actual process of entrainment.

6. **Conclusions**

In this paper we have examined the temporal dimensions and time lags within the governance of endocrine disrupting chemicals (EDCs) in Europe. Studying time and governance is valuable, as it touches upon not only regulatory effectiveness, but also questions relating to individuals' conceptions of time and how they act upon these. In this paper we put forward the concept of entrainment, or the act of'adjusting the pace or cycle of one activity to synchronise with that of another' (Ancona et al. 2001: 656), to investigate how the timescales within EDC governance could be matched.

We argue that within EDC governance there is a fundamental dilemma between two timescales – the criterial and impact time. The former relates to the temporal orientation of the regulatory bodies that attempt to establish criteria for regulating EDCs, whereas the latter concerns the timeframe of the chemicals that are controlled. The contrast between these two timeframes highlights the continuous challenges to establishing timely regulation of EDCs. In this paper we have argued that sidestepping or downplaying this temporal contrast solely amplifies the challenge at hand. To deal with this temporal problem we bring forward two interrelated approaches: practices and phronetic institutional entrepreneurship. Our analysis highlights that practices, or more specifically their temporal orientation, are absent in the EDC governance currently dominated by a criterial timescale. Integrating the temporal multiplicity of practices into the governance arrangement can prove valuable, as this opens up new opportunities of overcoming the slowness of criterial time by focusing on behaviour that is better aligned with the complexity of the hormonal impact time.

Furthermore, we argue that the entrainment of these three timescales – criterial, impact and practice time – requires a specific strategy, namely phronetic instititutional entrepreneurship. The focus is here on the ability of actors to recognise and accept the conflicting time frames and subsequently acting upon these. It requires us to remain open and adaptive towards temporal fluctuations within different spheres. Furthermore, the focus on institutions helps us treating the notion of entrainment critically and recognising the context in which this process takes place. In other words, entrainment will always be influenced and controlled by institutions as well as the organisational structure.

References

Adam, B., 1990. Time and Social Theory. Cambridge, Polity Press.

Adam, B., 1995. Timewatch: The Social Analysis of Time. Cambridge, Polity Press.

Adam, B., 1998 Timescapes of Modernity: The Environment and Invisible Hazards. London, Routledge.

Adam, B., 2003 Reflexive Modernization Temporalized. Theory, Culture & Society 20(2), 59-78.

Ancona, D.G., Goodman, P.S., Lawrence, B.S., Tushman, M.L. 2001. Time: A New Research Lens. Academy of Management Review 26(4), 645-663.

Ascher, W. 2006. Long-Term Strategy for Sustainable Development: Strategies to Promote Far Sighted Action. Sustainability Science 1(1), 15-22.

Beckert, J. 1999. Agency, Entrepreneurs, and Institutional Change. The Role of Strategic Choice and Institutionalized Practices in Organizations. Organizational Studies 20(5), 777-799.

Bell, S., Hindmoor, A. 2012. Governance without government? The case of the Forest Stewardship Council. Public Administration 90(1), 144-159.

DE-UK. 2011. Final Joint DE-UK Position Regulatory Definition of an Endocrine Disrupter in Relation to a Potential Threat to Human Health.

DK. 2011. Establishment of Criteria for Endocrine Disruptors and Options for Regulation.

DiMaggio, P.J. 1988. Interest and Agency in Institutional Theory, in: Zucker, L. (Ed.), Research on Institutional Patterns and Organizations: Culture and Environment. Cambridge, MA, Ballinger. pp. 3-22.

Dubinskas, F.A. 1988. Janus organisations: Scientists and managers in genetic engineering firms, in: Jones, F.A. (Ed.), Making Time: Ethnographies of high-technology organizations. Philadelphia, Temple University, pp. 170-232.

EC. 1999. 4th Report on the implementation of the "Community Strategy for Endocrine Disrupters" a range of substances suspected of interfering with the hormone systems of humans and wildlife (COM (1999) 706). http://ec.europa.eu/environment/endocrine/documents/sec_2011_1001_en.pdf

Ekengren, M. 1998 *Time and European Governance. The Empirical Value of Three Reflective Approaches*. Stockholm, University of Stockholm, Department of Political Science.

Elias, N., 1992. Time: An Essay. Oxford, Blackwell Publishers.

Flyvbjerg, B. 2001. Making Social Science Matter: Why Social Inquiry Fails and How It Can Succeed Again. Cambridge, Cambridge University Press.

Folke, C., Pritchard, Jr, L., Berkes, F., Colding, J., Svedin, U. 2007. The Problem of Fit between Ecosystems and Institutions: Ten Years Later. Ecology and Society 12(1), 30. [online] URL: http://ecologyandsociety.org/vol12/iss1/art30/.

Galaz, V., Olsson, P., Hahn, T., Folke, C., Svedin, U. 2008. The Problem of Fit among Biophysical Systems, Environmental and Resource Regimes, and Broader Governance Systems: Insights and Emerging Challenges, in: Young, O., King, L.A., Schroeder, H. (Eds.), Institutions and Environmental Change. Principal Findings, Applications, and Research Frontiers. Cambridge, MA, MIT Press.

Hardy, C., Maguire, S. 2008. Institutional Entrepreneurship, in: Greenwood, R., Oliver, C., Suddaby, R. & Sahlin, K. (Eds.), The SAGE Handbook of Organizational Institutionalism. London, Sage. pp. 650-672.

Hecker, M., Hollert, H. 2011. Endocrine disruptor screening: regulatory perspectives and needs. Environmental Sciences Europe 2011, 23**(**15), doi:10.1186/2190-4715-23-15.

Held, M. 2001. Sustainable Development from a Temporal Perspective. Time & Society 10(2/3), 351-366.

Hukkinen, J. 1999. Institutions in Environmental Management: Constructing Mental Models and Sustainability. London: Routledge.

Jordan, A., Wurzel, R.K.W., Zito, A. 2005 The Rise of 'New' Policy Instruments in Comparative Perspective: Has Governance Eclipsed Government? Political Studies 53(3), 477-496.

Karasti, H., Baker, K. Millerand, F. 2010. Infrastructure Time: Long-term matters in collaborative development. Computer Supported Cooperative Work 19, 377-415.

Krimsky, S. 2000. Hormonal Chaos. The scientific and social origins of the environmental endocrine hypothesis. Baltimore and London, John Hopkins.

Leca, B., Battilana, J. & Boxenbaum, E. 2008. Agency and Institutions: A Review of Institutional Entrepreneurship. HBS Working paper 08-096. Boston, MA: Harvard Business School.

Mahoney, J., Thelen, K. 2010. A Theory of Gradual Institutional Change, in: Mahoney, J.,Thelen, K. (Eds.), Explaining Institutional Change: Ambiguity, Agency, and Power. Cambridge, Cambridge University Press, pp. 1-37.

March, J.G., Olsen, J.P. 1989 Rediscovering Institutions: The Organizational Basis of Politics. New York, The Free Press.

Michael, M., Wainwright, S., Williams, C. 2007 Temporality and prudence: On stem cells as "phronesic things". Configurations 13(3), 373-394.

North, D.C. 1990 Institutions, Institutional Change and Economic Performance. Cambridge, Cambridge University Press.

Orlikowski, W., Yates, J. 2002. It's about time: temporal structuring in organizations. Organization Science 13(6), 684-700.

Pollitt, C. 2008. Time, Policy, Management: Governing with the Past. Oxford, OxfordUniversity Press.

Shove, E., Pantzar, M., Watson, M. (2012). Dynamics of social practice. New York, Sage.

State of the Art Assessment of Endocrine Disrupters 2nd Interim Report. 2011. Part I Summary state of the Science. http://ec.europa.eu/environment/endocrine/documents/summary_state_science.pdf

Stoker, G. 1998. Governance as theory: five propositions. International Social Science Journal 50(155), 17-28.

Tørsløv J, Slothus T and Christiansen S (2011a) *Endocrine Disrupters – Developing Criteria*. TemaNord 2011: 536.

Tørsløv J, Slothus T and Christiansen S (2011b) *Endocrine disrupters – Combination Effects*. TemaNord 2011: 537.

Vogel, J. 2004. Tunnel Vision. The regulation of endocrine disrupters. Policy Sciences 37(3-4), 277-303.

Voß, J-P., Kemp, R. 2006 Sustainability and Reflexive Governance: Introduction, in: Voß, J.P., Bauknecht, D., Kemp, R. (Eds.), Reflexive Governance for Sustainable Development. Cheltenham, Edward Elgar, pp. 3-28.

Young, O. 2003. Environmental Governance: The Role of Institutions in Causing and Confronting Environmental Problems. International Environmental Agreements: Politics, Law and Economics 3(4), 377-393

Young, O.R. 2008. Institutions and Environmental Change: The Scientific Legacy of a Decade of IDGEC Research, in: Young, O.R., King, L.S:,Schroeder, H. (Eds.), Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers. Cambridge, MA, MIT Press.

Zaheer, S., Albert, S., Zaheer, A. 1999. Time scales and organizational theory. The Academy of Management Review 24(4), 725-741.