***With Kant, Beyond Kant*: *The Organisational Approach to Naturalised Biological Teleology***

# Abstract

This paper critically examines the organisational approach (OA) to biological teleology in relation and opposition to Immanuel Kant’s notion of natural purpose. Whereas for Kant biological purposiveness leads to an antinomy of mechanism and teleology, the OA succeeds in *naturalising* biological purpose through the notion of biological organisation as self- maintaining and self-determining. In particular, I argue that the OA naturalisation strategy hinges on two theoretical moves: (1) adopting a pluralistic understanding of causality which conciliates mechanism and teleology in one causal network (through the notion of closure of constraints and Robert Rosen’s anti-Newtonian stance); (2) reinterpreting Kant’s own notion of natural purpose, by, *contra* Kant, centring self-organisation (‘epigenesis’) over organisation (‘design’). This work not only positions the OA in the contemporary ‘post-Kantian’ theoretical debates about biological teleology as a unique naturalising position but also identifies theoretical organisational bases for further studies regarding the role of biological self- determination in evolution.

**Keywords:** biological organisation, natural purpose, Kant, design, epigenesis, teleology, mechanism

# §1 – Introduction: situating the Organisational Approach

The ‘controversial legacy’ (Gambarotto & Nahas, 2022) of Immanuel Kant’s notion of intrinsic natural purpose (*Naturzweck*) has received increased attention in recent years within the philosophy of biology. Kant’s philosophy, despite or perhaps *because* of its tensions, has inspired virtually *all* positions regarding teleology (Rama, 2024), and it still informs and structures contemporary debates. In the ‘post-Kantian’ landscape, the organisational approach to biological teleology (OA) occupies a unique yet under-explored position.

The OA aims to provide a *naturalised* account of biological teleology grounded on biological organisation as self-maintaining and self-determining. Proponents of this view frequently cite Kant’s notion of intrinsic natural purpose as an “organised and self-organising being” (Kant, 1790, 374) as the philosophical precursor of their notion of biological organisation (e.g. Montévil & Mossio, 2015; Moreno & Mossio, 2015; Mossio & Bich, 2017; Mossio & Moreno, 2010; Ruiz-Mirazo & Moreno, 2012). Yet Kant, on *seemingly* the same organisational principles, denies the possibility of naturalising teleology. If for the OA biological organisation grounds teleology as a “legitimate and admissible conception of causality from the standpoint of natural science” (Mossio & Bich, 2017, 2), for Kant it is rather conducing to the antinomy between scientific causality (i.e. Newtonian mechanism) and teleology.

This paper critically examines whether and how the OA is successful in naturalising biological teleology, in relation and opposition to Kant’s original notion. I argue that the OA naturalisation strategy hinges on (1) a *pluralist* understanding of causality which, *contra* Kant’s antinomy, allows a conciliation of mechanism and teleology, and (2) a radical reinterpretation of Kant’s own notion of natural purpose or biological *telos*. The OA thus remains *with Kant*’s commitment to both mechanism and teleology, but also goes *beyond Kant*, operating an important reconceptualization of intrinsic purposiveness, allowing it to be *causally realised* in living systems. By comparing proximity and divergence between Kant and the OA, I hope to offer a better understanding of the organisational naturalising strategy, as it relates to Kant’s controversial legacy as well as to the resources offered by the biological autonomy tradition (e.g. Robert Rosen’s anti-Newtonian stance, the notion of organisational closure), so as to clarify how the OA poses itself as an alternative in contemporary debates.

To better characterise the OA and the stakes involved, the rest of this section introduces the contemporary post-Kantian landscape in biology as shaped by two ‘fault lines’, which can be traced back to Kant’s own tensions.

The first fault line concerns the status of biological teleology in relation to the Kantian antinomy (Gambarotto & Nahas, 2022). Kant resolves the antinomy by treating natural purposiveness as a regulative epistemic norm for biological knowledge. This *heuristic* stance is still embraced by recent scholars (Breitenbach, 2009; Desmond & Huneman, 2020; Lewens, 2007), sometimes linked to recent developments in evo-devo and the Extended Evolutionary Synthesis (Huneman, 2024; Moss & Newman, 2016).

Others have attempted a *naturalistic* answer to the antinomy. Recent studies (Gambarotto, 2023; Gambarotto & Mossio, 2024) have identified two possible paths. One is undertaken by enactivism (Di Paolo, 2005; Newen et al., 2018) and the ecological or behavioural approach (Fulda, 2016, 2017; Walsh, 2015, 2018). These mirror Hegel’s critique of Kant: teleology is ‘the truth of mechanism’, meaning that all mechanistic explanations of life already presuppose purposiveness, and the antinomy is a false problem. Accordingly, these approaches treat teleology as an *explanans*, never as an *explanandum* (Bich, 2024a, 16). The alternative path is undertaken by the OA, and consists in taking the antinomy ‘head-on’, *explaining* how mechanism and teleology are conciliated in organised causal systems.

The second fault line concerns the meaning of ‘purposiveness’. Kant’s notion of an ‘organised and self-organising being’ includes two aspects – what Huneman (2014, 2017) calls the *design* (organisation) and *epigenesis* (self-organisation) criteria. Design refers to the organism’s *form*, the ‘contrivance of parts’ that so fascinated Darwin (Gardner, 2009); epigenesis refers to its *activity*, its capacity to self-maintain, adapt, and develop. As Huneman (2017, 2024) shows, as purposive notions, design and epigenesis have informed evolutionary biology (especially Modern Synthetic adaptationism) and developmental biology respectively – albeit maintaining a heuristic connotation.

Mainstream accounts of teleology in biology have been predominantly evolutionary and hence focused on design rather than epigenesis. Proposals such as teleonomy (Dresow & Love, 2023; Mayr, 1974, 1998; Vitale, 2022) or selected-effects theory (Garson, 2016, 2019; Garson

& Papineau, 2019; Haig, 2020; Millikan, 1989; Neander, 1991) argue that organisms are purposeful because they have been *designed* by natural selection – it is often remarked that Darwin was the ‘Newton of the blade of grass’ that Kant deemed impossible. Nevertheless, it remains contentious whether these approaches genuinely naturalise teleology or reduce it to an epiphenomenon of evolutionary mechanics (Mossio et al., 2009, 821; Mossio & Saborido, 2016, 2). The OA is often cast in opposition to these approaches; as I will argue, its naturalising strategy is successful because it centres on epigenesis rather than design.

Read along these fault lines, the stakes for the OA are high. As Nahas and Sachs (2023) have recently argued, in debates over biological teleology, ‘naturalisation’ can assume a scientific or a metaphysical connotation, involving justifying teleology as a valid explanatory framework for biology or arguing that organisms really are purposive beings. If successful, the OA would naturalise teleology in both terms, providing a meaningful interpretation of

teleological and functional ascriptions based on organismal benefit and showing how mechanism and teleology are conciliated – not in thought, but in reality.

An explicit confrontation between Kant and the OA needs a preliminary terminological clarification. ‘Organisation’ and ‘self-organisation’ are Kantian expressions, indicating two aspects of natural purposiveness, respectively a whole-to-parts dependence, and the mutual productive relation between parts, design and epigenesis. The expression ‘self-organisation’ is generally avoided in the OA, due to its established use in non-equilibrium thermodynamics (Nicolis & Prigogine, 1977). Instead, the same Kantian meaning is expressed by talk of ‘self- production’ or ‘self-maintenance’. ‘Organisation’, in turn, also acquires a different meaning, as I will show, connected to a reinterpretation of the idea of the ‘whole’.

Throughout the paper, I will use Huneman’s wording of *design* and *epigenesis* to trace a line between Kant and the OA. My main argument – outlined in sections §§4-5 – is that while for Kant purposiveness depends heavily on design (self-organisation presupposes organisation), the OA turns Kant upside down, relying solely on epigenesis (self-organisation does not presuppose organisation). This change in perspective, as I will show, allows the OA to overcome the Kantian tensions that give rise to the antinomy.

However, I will also argue that design does not simply disappear; rather, it (implicitly) occupies a problematic position within the OA, pointing to directions for future research – particularly regarding the role of *regulation* in shaping the organism, and the role of organisational teleology in evolution.

In the next section, I explore the tensions within Kant’s notion of natural purpose – ‘nature’ vs ‘purpose’, ‘design’ vs ‘epigenesis’ (§2); afterwards, I overview the OA (§3).

# §2 – Tensions within tensions in Kant’s *Naturzweck*

The notion of an “organised and self-organising being” (Kant, 1790, 374) emerges from Kant’s effort, undertaken in the *Critique of Judgment* (1790), to think the possibility[1](#_bookmark0) of organisms as *natural purposes*. As scholars have recognised, Kant’s notion is replete with

1 Here ‘possibility’ is a modality of thought: formulating the concept of an entity means also to think it as possible.

tensions, particularly in the way ‘nature’ and ‘purpose’ interact (Ginsborg, 2004; Kreines, 2005; Zammito, 2006).

In Kant, ‘nature’ and ‘purpose’ describe two distinct forms of parts/whole relationship that ground the possibility of natural and purposive things respectively, and that are grasped by different epistemic frameworks, mechanism and teleology. Mechanism describes physical nature going from *general parts* (i.e. matter) to *particular wholes*, subsuming the existence of a particular (e.g. our Sun) under the laws of nature as described by Newtonian science (e.g. gravitation acting on matter) as its conditions of possibility (Ginsborg, 2006; Teufel, 2013). It is instead the domain of artefacts which provides Kant with “the idea of *general* purposiveness” (Huneman, 2017, 378; cf. Illetterati, 2014). Each part of an artefact is possible in relation to an *idea* of the whole as its *final cause*, its *telos*; specifically, whole-to-parts dependence is only possible where an idea of the whole – a plan, a blueprint – guides the production and unity of parts in an empirical whole, resulting in a teleological product. Because such ideas exist in the mind of their maker, artefacts are extrinsically purposive.

Natural purposes are *sui generis* beings, unlike any other natural or purposive things. Natural purposes ought to meet two requirements (Kant, 1790, 373), captured by design and epigenesis criteria introduced above (Huneman, 2014, 2017). First, like artefacts, “the possibility of its parts (as concerns both their existence and their form), must depend on their relation to the whole” (Kant, 1790, 373). Design thus captures the dependence of the parts on the whole – e.g. ‘spinnerets’ as such are impossible isolated from (the idea of) ‘spiders’.

Second, unlike artefacts, “if it [e.g. an organism] is to be possible only as a natural purpose, without the causality of concepts[2](#_bookmark1) […] the parts of the thing combine into the unity of a whole because they are reciprocally cause and effect of their form” (*ibidem*). Epigenesis thus refers to the mutual dependence of the parts by which they come to produce a whole. In turn, only if a natural system realises this kind of circular causality, for Kant, we can think the unity of its parts to be possible in relation to the whole they come to produce (*ibidem*). Thus, organisms are *self-organising*: their parts act so as to produce and shape themselves and the whole (not unlike other natural things[3](#_bookmark2)) in such a way that they display organisation, whole-to- parts dependence (quite unlike other natural things).

2 As it is the case for artefacts.

3 Even in non-living natural systems, parts can influence each other and the whole e.g. think of nuclear fusion within the sun, which turns hydrogen into helium.

In particular, self-organisation is displayed in multiple ways and levels of organisation. Following Kant’s own example, epigenetic processes are those by which, for instance, a tree produces another tree (reproduction), “produces itself as an individual” (growth and development), or displays a “mutual dependence between the preservation of one part and that of the others” (Kant 1790, 371) (organised self-maintenance). At all these levels, natural purposes are *intrinsically purposive*: their condition of possibility, their *telos*, is immanent to their very activity.

A question arises though: *why* does self-organisation, understood in terms of whole- producing mutually dependent parts, identify a kind of organismal purposiveness, rather than a complex, but still mechanical system?

As shown by Ginsborg (2004), for Kant both organisation and self-organisation are ‘mechanically inexplicable’: on the one hand, organisation cannot be derived from the laws of nature alone[4](#_bookmark3) (ivi, 53), meaning that, unlike for non-organised natural things like mountains or solar systems, “the existence of matter alone, without any special arrangement, does not necessitate the existence of organisms with their complex patterns of behavior” (*ibidem*). On the other, even given ‘organised matter’, “organic change cannot be explained by showing how one material configuration follows from another according to the laws of motion” (*ibidem*; here ‘organic change’ refers to the particular self-organising activity of the parts involved in physiological and developmental process). But if parts-to-whole causation is the domain of mechanism, what stops us from considering epigenetic processes a complex, but still mechanistic form of causality? The reason is that epigenetic activities display design: self- organisation *implies* organisation. This is the crux of Kant’s natural purpose – which betrays a residual commitment to an ‘artefactual’ notion of purposiveness (Illetterati, 2014). ‘Design’ ultimately prevents Kant from formulating a fully naturalistic concept of purposiveness. Let me explain.

As Kant puts it, organisms are endowed with a “propagative *formative* power that cannot explained through the mere power of motion (the mechanism)” (Kant, 1790, 364), which is something like the imprinting of a ‘form’. To use Kant’s own example, he interprets the metabolism of a tree (a kind of epigenetic activity as defined above) as imparting tree-like form to formless matter (nutrients), a form which cannot be found outside of the tree’s own activity

4 Which is not to say that they are incompatible with them: organisms are not non-mechanistic islands in a Newtonian ocean.

(Kant, 1790, 371). At the same time, such ‘form’ is mechanically inexplicable (in Ginsborg’s first sense). Thus, while epigenesis shows us the organism’s internal purposiveness, it also seems to presuppose design – a whole-to-parts dependence which Kant thinks in terms of causality by idea of a whole. In other words, self-organisation is Kant’s way of thinking of how something *like* artefactual purposiveness can be displayed in nature.

If, as argued by Teufel (2014), for Kant mechanism is necessary and *sufficient* to explain the “corporeal reality” (61) of organisms (e.g. how nanoscale physics makes morph butterfly wings blue, how intracellular signals induce differentiation etc.), then what exceeds mechanism and requires us to think teleologically seems to be a “phenomenal awareness” (*ibidem*) of organismal design, how parts seem to operate in accordance to an idea of the whole – the ‘organisation’ in ‘self-*organisation’*. But this interpretation might be too unbalanced towards the design criterion: if Kant deems absurd “to hope that may yet arise a Newton who could make comprehensible even the generation of a blade of grass according to natural laws” (Kant, 1790, 400) – what is it about the *generation* (the epigenesis) of the blade of grass, rather than solely its grass-blade-like form, that resists mechanical explanability?

In the *First Introduction* to his third *Critique*, Kant defines purposiveness as the “lawfulness of the contingent as such” (*First Introduction* XX 217.28). Typically, ‘lawfulness’ signifies the necessity of mechanical phenomena; the contingent appears ‘as such’ precisely in relation and opposition with mechanical lawfulness. Both artefacts and organisms are contingent in this sense – there are no laws of nature necessitating the design of books or whales. While artefacts can be explained by reference to a maker, organisms, as natural entities, pose a problem.

Huneman (2014) makes the interesting point that the ‘lawfulness of the contingent as such’ marks the introduction of a *normative* dimension in our understanding of epigenetic processes (see also Ginsborg, 2006). For example, from the perspective of mechanical necessity, “a normal chick and a ‘monster’ or a non-viable chick are on a par: the laws of physics […] account for their production, and from this viewpoint there is nothing special concerning the normal chick” (Huneman, 2014, 7). But biology involves normative considerations e.g. the difference between viable vs non-viable physiology or behaviour, normal vs teratological development, which suggest “a certain intelligibility of such contingent entities, structures, and processes” (*ibidem*), a lawfulness which is not mechanistic yet is natural. Teleological, functional and normative ascriptions in biology thus seem guided by an

idea of the whole (design), which provides a ‘hypothetical presupposition’ of a particular lawfulness governing the activity of the parts (their epigenesis). Translated in modern terms, design describes the *canalisation* of epigenetic processes (self-maintenance as well as development) towards a determinate form, understood as goal-directed and thus normative, rather than as a mere mechanistic effect (cf. Huneman, 2024, 132).

There is however a *non-coincidence* between the *whole as* (real, mechanical) *effect* of the parts, and the *whole as* (ideal, final) *cause*. The first is empirically given to us; the second is not and cannot. As mentioned, Kant’s opts for a ‘heuristic’ stance, taking final causes as ideas of the whole that regulate our biological research – a solution, as Ginsborg (2001) argues, which only displaces the tension on the epistemic level.[5](#_bookmark4) Here I want to consider a different issue though: where do we take such regulative ideas from? How do they perform their regulative work?

Consider a rare gynandromorph butterfly (half-male half-female). How are we to discern whether it deviates from its (our) ‘blue butterfly’ idea (it is a monster), it conforms to *another* idea (it is not a blue butterfly), or it requires us to update our original idea (blue butterflies *can* be gynandromorphs)? We lack an *a priori* reason of discernment (its lawfulness is in fact contingent), nor we can simply infer it from experience (whose meaning is precisely what is in question). For ideas of the whole to regulate our judgment, they ought to be in some form already available to us, while being neither empirical nor transcendental (Huneman 2014, 10).

I believe here it is useful to make explicit the character of *contingency* (or *temporality*) proper to our ‘phenomenal awareness’ of natural purposes. Here contingency names “the possibility of not being, or of being different” (16). The point I want to make here is that natural purposiveness is contingent in a twofold sense. First, the whole organisation, as we make hypotheses of it, unfolds temporally, it is never given to us such that all its possible parts are also existent, as necessary. Thus, its parts and their activity retain a *phenomenal element of contingency*: they can be surprising, they can exceed the hypothetical normative whole, prompting us to revise our assumption. Second, whereas mechanistic laws are assumed to be necessary invariants of nature, the ‘lawfulness of the contingent as such’ is in itself contingent *exactly* because it is manifested temporally and partially. Let me clarify with an example.

5 Quoting: “how can we coherently regard an object as a product of design, while at the same time regarding it as natural? […] there is no such thing as regarding something as if designed, without regarding it as in fact designed” (Ginsborg, 2001, 8).

Imagine a caterpillar building its cocoon. We can think of the moth (moth-like parts and properties attributable to the same individual) as still only possible and contingent: the caterpillar *can* turn into a moth, but this is not necessitated by natural laws. At the same time, our idea of the moth does not necessarily foresee all its possible determinations – it might develop unexpected wing colours (a case of what we today would call phenotypic plasticity). On the one hand, we have the ‘empirical’ contingency of temporal-causal series of parts and the whole they produce; on the other, we have the ‘transcendental’ contingency of the idea of the whole we formulate. This latter contingency, I hold, is not just a logical property of our experience (insofar as we think the moth as only possible), but a property of the very object under study – not an artefact, but a self-organising whole organism, whose form ultimately depends only on the activity of its parts.

Were we to be able to grasp its whole-to-parts dependence, we would have what Kant calls an ‘intuitive understanding’ of the moth (Kant, 1790, 401ff). This has “no objects except what is actual” (402), while at the same time treating its objects as a concept, abstracted from their temporal manifestations. Such an intuition would lack the contingency proper to our experience of organisms, where a caterpillar *can* become a moth, and a moth *can* have brown or white wings. Instead, it would grasp the whole moth in one glance, where the relationship between its parts (e.g. caterpillar-stage and moth-stage, brown wings and the rest of the body) would not be temporal-causal, but logical – much like ‘having tree angles’ implies ‘having three sides’. Yet, this is not how we experience organisms.

For example, both physiology and developmental biology are concerned with normatively evaluating organic changes, albeit over different rates and kinds of changes (e.g. changes in heartbeat in response to stress, normal vs abnormal rates of embryological development). Both rely on the idea that, while contingent, these changes are not random, but they depend on their role in a whole. Such a whole, however, is not given *as such*, as a final cause, but always only as an effect of its parts – to repeat Ginsborg, of these very ‘organic changes’. This is why the idea of an organism’s internal purposiveness is a regulative ideal: it is a hypothetical assumption created and recreated out of the encounter between our epistemic need to understand organisms teleologically, as if *designed*, to grasp their “systematic unity” (373), and the contingency and open-endedness of biological processes. In this sense natural purposes are ‘intrinsic’: their assumed *telos* is in itself subject to the very changes they ought to explain.

We can say, for Kant, not only intrinsic purposiveness is the product of our finite understanding, but it is also identifies a specific phenomenology pertaining to living beings: they ‘tend’ to somewhere – caterpillars become moths, and plants grow leaves – which we can approximate and hypothesise (assume a design) – yet their lawfulness, which is supposed to ground our functional and normative ascriptions remains itself a contingent projection. Thus, the *regulative* status of natural purposiveness accounts for the essential open-endedness of epigenetic process insofar as we observe them. We should hear in ‘open-ended’ both meanings of the word *end* – mechanical *products*, ‘end-states’, are open as much as the *goals* they are directed towards. Finally, it is because of this open-endedness of our phenomenal experience of design in organisms that no objective, naturalised knowledge of organisms as purposive is possible.

To sum up, Kant’s notion of natural purpose is dominated by two tensions: (1) between nature and purpose, that is, between mechanism and teleology as different explanatory stances, and (2) between design and epigenesis, that is, between the idea of the whole, and the irreducibility of organic changes to it. These tensions are solved by Kant at the transcendental level, by taking purposiveness, particularly design, as an always revisable epistemic norm.

The issue and role of temporality or contingency is not explicitly thematised by Kant. I believe, however, that this rumination will help enlighten how the OA pursues its naturalisation strategy. If the OA can do without ideas of the whole as *telos* – without a design criterion – does it manage to formulate an entirely ‘epigenetic’ internal purposiveness, conciliating teleology with the organism’s open-endedness?

# §3 – The OA: the minimal model and the regulated model

Despite being rooted on the “inherent connection between self-determination, teleology, and biological organisation […] traced back to Immanuel Kant’s *Critique of Judgment*” (Mossio & Bich, 2017, 1094) the OA’s outcome is diametrically different. Whereas for Kant the notion of intrinsic purposiveness is symptomatic of an epistemological limit, for the OA it is the key to naturalise teleology in the biological world. But why? Is it simply because “In contrast to Kant we are no longer dependent only on speculations concerning self-organisation in nature” (Weber and Varela 2002, 101), and we can consider teleology as an *empirical* and

thus fully given and explainable property of organisms (ivi, 120), or does the OA manage to describe a scheme of self-determining organised causality which does not rely on any supplement of ‘ideality’ to conceptualise final causality?

The OA has undergone some iterations, and it is rooted in the biological autonomy tradition (Kauffman, 2000; Maturana & Varela, 1980; Rosen, 1991). I will focus on its recent systematisations, particularly the ‘minimal model’, focused on self-maintenance, and the ‘updated model’, which centres on biological regulation.

In the ‘minimal model’ proposed by Mossio and Bich (2017), self-determination (i.e. internal purposiveness) is achieved by a circular causal regime termed ‘closure of constraints’ (see also Montévil and Mossio, 2015), which can be seen as a contemporary and more theoretically advanced formulation of Kant’s notion of biological organisation as mutual dependence between parts.

Biological organisation is an “inter-level causal regime” (Mossio & Bich, 2017, 1105) comprised of two causal sub-regimes, cycles of processes and closure of constraints. Processes are physico-chemical transformations that make up the thermodynamic flow transversing the organism, enabling the construction, destruction, and alteration of the organisation’s parts. Constraints instead are relatively table structure that affect, shape, and harness such processes, while remaining locally unaltered at the time scale in which processes take place. Examples are the cardiovascular system constraining blood flow, or enzymes constraining chemical reactions. By constraining processes, constraints produce and maintain each other, in different but complementary ways, realising mutual dependence. Importantly, the difference between processes and constraints is a matter of time scale. For instance, our skin acts as a constraint at one (faster) time scale e.g. it constrains and controls temperature, hydration etc., but is also ‘a process’ over another (slower) time scale e.g. undergoing material turnover in the span of a month or so (see Montévil & Mossio, 2015, for a discussion of slow and fast dependence between constraints within closure). Biological organisation is thus characterised by *thermodynamic openness* (intake and outtake of matter and energy) and *organisational closure*.

Within biological organisation, constraints also “specify […] the conditions under which the effects contribute to generating their own causes” (Mossio & Bich, 2017, 1107), their *conditions of existence*. In this sense, constraints are *mutually constraining*, and the system as a whole realises self-determination as *self-constraint*. Notably, ‘conditions’ has a somewhat

double meaning here: constraints are *cause* and prerequisites *for* existence, but they also qualify the way such existence is carried out (an organism’s ‘life conditions’).

Two central Kantian themes find here their contemporary formulation: the relation between mechanisms and teleological organisation, and the whole as *telos*. First, thermodynamic openness and organisational closure spell out the way efficient mechanical causality and final causality interact. Constraints, insofar as they harness the organism’s thermodynamic openness, are efficient causes i.e. they produce each other and the whole; insofar as they are subject to organisational closure, their existence, mode and rate of activity is determined by and within the whole, they constitute the organisation’s final cause(s). Second (and relatedly), the OA strategy consists in reinterpreting the whole as *telos* in terms of conditions of existence:

…the conditions of existence on which the organisation exerts a causal influence can be interpreted as the goal (*telos*, or final cause) of biological organisation: because of the dependence between its own existence and the effects of its activity, biological organisation is legitimately and meaningfully teleological. […] [I]n the case of biological systems their goal and their own existence are one and the same thing. (1090)

Not all conditions of existence of an organism constitute its *telos*. The existence of an organism is also conditional on the presence of things like appropriate prey, shelter etc. (what Mossio and Pontarotti (2022) call ‘independent constraints’). But independent constraints are not produced and shaped by the organisation itself, they are not ‘cause and effect of themselves’, and thus they are not final causes.[6](#_bookmark5) Instead, “conditions of existence of the constitutive constraints are, because of closure, mutually determined within and by the organisation itself”(Mossio & Bich, 2017). When efficient causes are organised, they are endogenous conditions of existence, and thus also final causes.

On this basis, closure also grounds functionality and normativity. Conditions of existence identify the norms of the system’s activity: the organism should behave in a certain way “otherwise it would cease to exist” (Saborido and Moreno 2015, 88).[7](#_bookmark6) In turn, a constraint’s

6 Things such as nests, hives etc. might be considered part of a larger self-determining organisation though (e.g. bird+nest), to the extent that are products of organisms and contribute to maintain these organisms themselves, (Mossio & Pontarotti, 2019, 12).

7 See Corti (2023) for a critique of the counterfactual nature of the OA argument for normativity.

function is identified with its contribution within the division of labour of the system, and it is functional if it promotes such conditions of existence: “Closure of constraints is […] closure of functions”, Moreno and Mossio 2015, 71; cf. Mossio et al. 2009).

We should also dwell for a moment on the meaning of ‘existence’ in this minimal model, as I believe it is susceptible to an important shift in the updated model. Closure here seems to be understood as an inherently stable regime. Given a set of mutually dependent constraints, closure *self-maintains*, that is to say, it constantly meets said endogenous conditions. But the dynamic range of such a system is very limited. In the face of external perturbations, for example, this system displays relative flexibility, or ‘dynamical stability’: perturbation might momentarily alter the rate of a constraint, but due to mutual dependence, perturbation is ‘absorbed’ (Bich et al. 2016, 247), and the system regains its initial state – like a rubber band. If perturbation exceeds the range of flexibility, a constraint can fail to perform its function. Because all constraints are mutually dependent, if one fails, the others lose their conditions of existence – like a domino, the whole system fails – (Christensen & Bickhard, 2002) effectively call this predicament ‘dysfunction propagation’. This shows us that, for a minimal organisation, to exist through time also means to maintains itself *identical*. While it can sustain quantitative changes, a minimally self-maintaining system like this cannot undergo qualitative changes i.e. changes in the set of functions. For this reason, I claim that for a minimal organisation to self- maintain means to *persist*, to remain the same through time. Conditions of existence are thus conditions of persistence.

To be fair, already (Montévil & Mossio, 2015) state that we encounter stability as much as variation in biological organisation: “The invariance [read: persistence] of closure grounds the stabilisation of the functional organisation. Stabilisation, however, does not prevent variation” (25). Indeed, constraints themselves can promote functional changes (26). Yet, at this level, variation still appears submitted to an “invariance of closure” that is “*higher* than […] each specific organisation (instantiated by an individual system)” (*ibidem*). By identifying a higher level of closure, variations at lower levels become synonym with the “contingency of biological systems” (*ibidem*), i.e. their susceptibility to noise, replication errors, environmental blows, and other extrinsic changes that ought to be ‘dealt with’. While recognising a certain level of changeability, this does not seem to affect the ultimate conditions of existence, which are still thought to have to *persist*. Lower-level functional changes are essentially compensatory, *conservative*. As I am going to show now, taking into account biological

regulation allows the updated OA model to do away with the assumption of a higher level of invariance, suggesting a rather open-endedness of organisational closure. This has important implications for the organisational notion of teleology.

The recent ‘update’ on the OA expands beyond self-maintenance, to offer a richer account of purposiveness grounded on regulatory control:

Closure has the virtue of accounting for a fundamental feature of living systems, the capability to produce and maintain components (and the system itself) by establishing the conditions of existence for internal processes. However, taken alone it is insufficient to explain what living systems do and how they maintain themselves, that is, some of the distinctive features of biological organisations. (Bich, 2024b)

Indeed, regulatory functions are central to the organisational accounts of many dimensions involved in self-maintenance in the biological world e.g. integration and complexity management, autonomy, agency and minimal cognition (Bich, 2018; Bich & Bechtel, 2022a, 2022b; Moreno & Mossio, 2015), adaptivity (Bich et al., 2016; Menatti et al., 2022), dealing with pathologies (Saborido et al., 2016; Saborido & Moreno, 2015), as well as development (Bich & Skillings, 2024). My discussion of the regulated model here is rather directed at spelling out the further elaboration of the meaning of teleology in the OA.

Within a biological organisation, constitutive constraints are subject to *second-order* closure with a subset of regulatory constraints. Regulatory constraints are produced by and act upon other constitutive constraints. While the latter constrain each other by means of their very productive activity (by constraining processes), regulation is ‘decoupled’ by constitutive closure i.e. their functioning is relatively independent from metabolic activity. Regulatory activity is instead *triggered* by specific changes in internal and external conditions (Bich et al., 2016; Moreno & Mossio, 2015). In turn, it controls and mediates transitions between constitutive functional regimes i.e. promoting the loss, gain, and overall change in constitutive functions (Bich et al., 2016). In this way, as argued by Bich (2024a, 2024b), regulated organisation does not simply set and achieve its goals in the same activity, but actively and adaptively controls and pursues them (ivi, 9-10). While in the minimal model, ‘establishing’ and ‘achieving’ goals (differently put, ‘having’ and ‘performing’ functions) could be considered

logically equivalent activities performed by the same entities, here constitutive constraints achieve conditions of existence established by higher level regulation.

What is important here is not that ‘it takes more’ to stay alive (more levels of constraints, more control etc.), but rather that internal teleology appears to be a much more complex affair than the achievement of one invariant *telos*. To be fair, it might be *useful* to assume something like an ‘invariant’ *telos* even for complex systems – for instance, Barandiaran and Moreno take an organisational approach to neurocognitive functions based on the idea of regulation acting on behalf of a normative cognitive identity, a ‘self’ (Barandiaran and Moreno 2006; Moreno and Mossio 2015, 187 ff.). Bich and Skillings’s (2024) organisational treatment of development suggests instead a more nuanced view of regulation, understood as a principle of qualitative functional change. I will further articulate the implications of this view in section §5; for now, the following discussion takes developmental change not as a *sui generis* biological process (compared to ‘normal’ self-maintenance), but as paradigmatic of the way organisms determine their own mutable *telos*.

Bich and Skillings challenge the received adultocentric (Minelli, 2011) view of development as goal-directed towards maturity to propose a view “that centres on the maintenance of the living system from the very beginning of development” (Bich & Skillings, 2024, 249). In their view, *there are no intermediate stages*: every stage is its own goal “because the system must build and maintain itself at every point of its existence” (250). Applying the OA to development “means identifying the *telos* of the developing system in its current organisation, rather than in a future state” (251). Later on: “the *telos* of the system is grounded in the maintenance of the viability of the organism at each stage of development, rather than in a future state” (253). In their proposal, regulation is used to account for change between profiles or developmental stages:

To undergo development, this organisation should also exhibit regulatory capabilities, that is, be able to determine its own process of change. […] Development is qualitatively different from other regulatory processes because it does not operate only on available functions but also changes the set of functions available to the system. At each developmental step, some new functional traits are generated, such as in the appearance of new tissues, organs, or limbs (256).

Take a tadpole developing into a frog. If the intrinsic *telos* of a tadpole is to self-maintain at any point of its life, why does its regulatory system ‘disrupt’ its ‘tadpole-closure’ (which gills and tail) to leave space for the ‘frog-closure’ (which lungs and legs), both performing different functions according to different norms? Other cases of metamorphosis (e.g. butterflies) are even more radical, as seemingly no higher-level function or closure persists between stages. In the minimal model, closure is said to be self-determining because constraints contribute to each other’s conditions of existence. Yet here, regulation seems to break this circularity.

As I mentioned, the meaning of ‘existence’ here undergoes a shift, as clearly the system’s goal cannot be to persist as it is, or alternatively, its self-determination cannot be understood in terms of persistence of a stable configuration. A possible clue to dissipating the apparent tension is suggested by DiFrisco and Mossio’s (2020) discussion of diachronic identity in complex life cycles. In their account, ‘identity’ – what is supposed to persist and qualify the organisation’s goals – is recast in terms of organisational *continuity* i.e. “the presence of a continuous causal process linking successive organizational regimes, irrespective of material and functional changes” (1; cf. Mossio & Pontarotti, 2019; Pontarotti, 2024). This clearly supports the idea that there are no ‘intermediate stages’ in development: “an ontogenetic trajectory does not have to conserve anything in particular, neither structures nor functions” (DiFrisco & Mossio, 2020, 6), nor any *telos*.

Non-intermediate *teloi* appear to be unstable things, such that they cannot be effectively regulated into indefinite self-maintenance. Quoting: “Change is understood in terms of ‘structural determinism’, that is, all changes a living organization undergoes at a given moment are determined by its structure at that specific moment” (Bich and Skillings 2024, 254). It seems, organisation itself, by its own properties, is the sort of thing which *must* change in order to self-maintain. In turn, self-maintenance, or existence, is not understood in terms of persistence, but organisational continuity. Continuity, unlike persistence, does not require the conservation of functions – e.g. even one-shot functions can be subject to closure (Mossio & Saborido, 2016, 7). Regulatory functions themselves need not to be invariant or particularly more stable in order to exert their control over constitutive changes – e.g. we cannot admit that the regulatory functions of a caterpillar are the same as those of a moth. Regulation here ‘connects’ stages, endowing them with a ‘directionality’ – it *canalises* changes in forms of self- maintenance. While this view is not ‘future oriented’ (as in, the goal of the system is not to

achieve a determinate future state to be e.g. a mature reproductive stage, but to self-maintain at every state), we can still say: if an organism ought to have a future, it has to change[.8](#_bookmark7)

Concluding this section, I want to clarify in what sense ‘to live is to change’. Jaeger (2024) has recently associated the principle of organisational continuity to, to use Hans Jonas’ words, the organisms’ ‘thermodynamic predicament’, its necessity to engage in continuous regeneration to keep alive. Yet, this is only ‘material’ change, which does not affect the form of the organisation. The regulated model suggests a *sui generis* view of organisational teleology, seemingly at odds with the minimal model of thermodynamic opening / organisational closure. If the minimal model is grounded on the ‘closed’ character of organisation, its circularity, the updated model suggests that organisation is in itself rather ‘open’: to live is to change, not (just) materially, but formally, functionally. To recuperate the wordings introduced in section §2, the organism’s *design* ought to change. Accordingly, closure, as identified *by* the mutual dependence of constraints, ought to be maintained at *all* times, not *through* time. By this I mean that “the invariance of closure” as a “constitutive principle[…] of biology” (Montévil & Mossio, 2015, 26) does not describe a determinate set of traits and functions, but a *general* and *abstract* relation between whatever traits and functions are operative at any given moment. Therefore, if meeting the organisation’s conditions of existence (the system’s *telos*) also means to change them, internal purposiveness itself undergoes change through time. In this sense, as I will further discuss in section §5, organisational teleology is radically *epigenetic* in a Kantian but naturalised sense.

# §4 – Beyond the antinomy

Kant’s view on biology as a science is problematic, depending on whether we expect biology to explain natural purposiveness. There is no doubt, however, that for Kant there is

8 Clearly not all regulated changes are developmental changes, such that they affect regulatory constraints themselves. These can indeed be described as typically more stable than the systems they regulate, operating on a sort of *meta-functional* level (Moreno and Mossio 2015, 36; Saborido and Moreno 2015, 90), particularly when their function is to manage complexity and promote integration over larger time scales. Adaptively switching between constitutive regimes in a context-sensitive manner (e.g. switching between metabolic regimes according to food availability) does not typically count as developmental change. Nonetheless, the OA approach to development highlights a changeability of biological organisation which is not simply due to environmental perturbations, but it is rather internally determined.

only one causal framework available to natural science, mechanism (efficient causation) – leading to the antinomy regarding our judgment of organisms. The OA, as I will discuss in this section, assumes instead a pluralist conception of causality, an “expanded mechanism” (Wolfe 2024, 45) which holds efficient and final causation together (4.1). Kant’s antinomy also hinges on a particular *difference* between how the whole is treated by mechanism and teleology, either as an efficient product, or as a final cause. Since teleology involves whole-to-parts dependence, epigenetic parts-to-whole processes, by displaying design, appear teleological. As we are going to see, the OA, by redefining the whole as emergent, removes the need for a design criterion, thus making teleology and mechanism compatible within the same causal scheme (4.2).

# – Causal pluralism

We have already encountered different forms of causality within the OA, in the form of processes and constraints. This ‘causal pluralism’ has its roots in the work of Robert Rosen in particular. Rosen’s anti-Newtonian stance – captured by the title of his essay *Organisms as Causal Systems Which Are Not Mechanisms* (Rosen, 1985) – appears to tackle exactly what Kant missed to see, that the problem for biology is not teleology *per se*, but a too narrow view of causality.

Rosen’s critique is directed at what he calls the ‘Newtonian paradigm’, the idea, which “everyone routinely supposes”, Kant included, that the relation between physics and biology is “that of general to particular” (166). The Newtonian view of a universe of structureless particles governed by forces acting upon them, while appropriate to physics, has been unwarrantedly taken as paradigmatic of *all* sciences, biology included.[9](#_bookmark8) Indeed, Kant can clearly be seen as committing to the Newtonian paradigm criticised by Rosen, insofar as he takes parts-to-whole, general-to-particular mechanistic explanation as the paradigm of scientific knowledge, in relation to which biological systems display a non-general, particular and contingent lawfulness, which thus exceeds scientific knowability. To criticise the Newtonian paradigm, Rosen rehabilitates Aristotle’s four causes, the idea that there are multiple ways of saying ‘why’, and accordingly, that entities can perform different causal roles. In particular, he attacks the *causal segregation* i.e. the idea that one kind of entity or property

9 For a critique of this way of thinking in Modern Synthetic evolutionary biology, see Walsh (2017).

can perform only *one* causal role, and the refusal of final causality proper to the Newtonian paradigm.

According to Rosen, in Newtonian equations for physics explanations, the initial state of a system plays the role of material cause, properties of the particles are formal causes, while the forces acting on them are efficient causes; final causes are absent. Additionally, causal roles are segregated: for instance, whereas the initial state of the system can change (making it a ‘material’ cause), the nature of the forces in action cannot, they are not subject to further transformation by other causes.

Rosen’s concept of an (M,R)-system (a system capable of metabolism and regeneration/replication, an antecedent to the contemporary ‘closure of constraints’) reveals the limitations of the Newtonian paradigm for biology. In particular, components within an (M, R)-system can simultaneously or successively serve multiple causal roles (material, efficient etc.), in sharp contrast with Newtonian causal segregation (ivi, 193). We find the same feature in the contemporary OA idea that the difference between processes and constraints i.e. between material and efficient causation, is *a matter of time scale*, as well as in the mutual dependence between constraints, which are at once efficient and final causes.

(M, R)-systems, and by extension closure of constraints[10](#_bookmark9), are not merely efficient causal systems, circularly wrapped onto themselves. They are *causally pluralist* regimes, in which entities perform a variety of causal roles, which allow them to self-maintain, as follows. (1) The thermodynamic flow transversing the system has a *material* causal role. (2) Structures that harness such flow without being affected by it, and contribute to the production of other structures, are *efficient* causes. Insofar as they also undergo transformation, they are material causes as well, they are part of the organisation’s thermodynamic flow. (3) *Formal* causation refers to the system’s topology, the organisation of efficient causes. (4) Finally, *final* causation is the inverse of efficient causation: if x is efficient cause of y, then y is final cause of x (the existence of x can be understood by appealing to its role in producing y). In particular, when they realise circular dependence, efficient causes can be ‘inverted’, they can respond to final causation and be goal-directed – and thus produce the whole on behalf of the whole itself – *because* they operate by harnessing matter and energy and providing other parts with their material causes in an organised fashion. In doing so, they indirectly determine how they

10 And possibly any class of self-productive system; cf. Letelier et al. (2003).

themselves are materially maintained as constraints. In other words, the OA couple of thermodynamic openness and organisational closure involves entities performing diverse and reciprocally implicating causal roles.

Furthermore, these four causal categories cannot be considered separately in self- organising systems. They constitute a unitary scheme, appropriate to organisms and their epigenetic activity. For instance, we cannot understand how constraints produce other constraints (efficient causation) without taking into consideration that they constrain energy and matter to produce them (material causation, which in fact does not happen unconstrained), nor without considering the network of dependencies (formal causation) that allows constraints to maintain their own constraining, productive activity stable (final causation). A full organisational explanation ought to take into consideration all four dimensions as reciprocally implicating (as more recently supported by Bich and Bechtel, 2021).

In this way, the antinomy appears dissolved: mechanical processes (e.g. how individual constraints operate) cannot be explained by ‘merely mechanistic laws of nature’ as per Newtonian paradigm (parts-to-whole), but they ought to be explained by reference to the organisational context that maintains them *due* to their functional role (whole-to-parts *sensu* OA i.e. functional presupposition). The causally pluralist nature of closure of constraints provides the in-principle justification for this explanatory integration.

Clearly though, this ‘synthesis’ – the achievement of a *unitary* and *pluralist* causal scheme – is not simply a way of connecting otherwise independently defined causalities. If mechanism *sensu* Newtonian paradigm is overcome, it is plausible that teleology itself is transformed, especially insofar as it was previously defined, in Kant, in *opposition* to such mechanism. On this very basis, I will show how the OA drops the design criterion, grounding natural purposiveness on fully epigenetic bases.

# – Dropping the design criterion

As we have seen, in Kant’s framework, the design criterion here gives us the idea of a possible whole, which determines *a priori* all the parts that can be given through that very idea (Kant 1790, 373). In this sense it is the condition of *possibility* of such parts, where ‘possibility’ here signifies a modality of thought. When judging organisms as natural purpose, we compare

the empirical whole, as a mechanical product of its parts, to an ideal whole, which allows us to judge whether form and activity of the parts follow an assumed non-mechanistic lawfulness, or they are mechanical aberrations (recall the chick or gynandromorph butterfly examples in

§2). The whole as *telos* can be said to be *transcendent* on its parts in two senses: it exists in our mind, rather than in nature; it is never fully given in our phenomenology, and the empirical whole, as a purposive product of its parts, never exhausts its design (for if it did, we would not need a design criterion to guide our knowledge).

The OA naturalising strategy instead recasts the *telos* as conditions of (continuous, self- maintaining) *existence*, rather than possibility. Such conditions are established and articulated through their mutual dependence – an aspect already emphasised by Kant’s epigenesis criterion. This mutual relation is sometimes described in terms of ‘functional presuppositions’ (Bickhard, 2000; Christensen & Bickhard, 2002; Moreno & Mossio, 2015; Saborido & Moreno, 2015). While the notion of ‘presupposition’ has an important *ad hoc* normative connotation (e.g. Saborido and Moreno use it in a tentative account of malfunction), it also captures what mutual dependence consists of. Given a constraint, its “structure […] is such that it ‘presupposes’ that it will enter in a regime of interactions not only allowing a generic viability, but also the appropriate regime of interactions” (Saborido & Moreno, 2015, 91-92). In turn, the function of a constraint is to “satisfy[…] the dynamic presuppositions” (Bickhard, 2000), that is to say, to contribute to the activity of other constraints in such a way that the latter can perform those activity that also maintain the former. For example, the functioning of a heart ‘presupposes’ that lungs are granting oxygen intake, and that vascular system effectively brings oxygen-rich blood to the cells; vice versa, lungs and vascular systems also ‘presuppose’ that the heart beats etc.

In this perspective, conditions of existence are functionally and reciprocally differentiated ‘from within’, through the mutual interaction of constraints (including regulatory constraints, cf. Bich, 2018; Bich & Bechtel, 2022b). In teleological terms, a natural purpose establishes, maintains, and pursues as its *telos* those conditions that are functionally determined within its organisation *as it is*. In stark opposition to Kant’s view, for the OA final causes are *immanently* determined by each part’s functional requirements as they are shaped by their very own activity. They are not dependent on the whole as a principle that dictates how each parts ought to function, but they are functional (and thus have a goal) insofar as they realise mutual dependence *within* and *as* a whole.

This same immanence is clearly displayed in the organisational treatment of the *emergence* of the whole, discussed particularly by Mossio et al. (2013; cf. Moreno and Mossio 2015, 61 ff.). As Mossio and co-authors notice, it is Kant that evoked the idea that “the existence of the constituents (the constraints) ‘depends on the whole’” (Mossio et al. 2013, 18). This seems to imply that the whole is ‘more than the sum of its parts’, and that it imparts a specific kind of causality on them. The OA, however, denies the necessity of this interpretation: “‘Depending on the whole’, therefore, could simply mean ‘depending on the whole network of interactions’ without appealing to the whole as causal agent emergent on its own supervenience base” (*ibidem*). This network of interactions, as seen above, can be read both in efficient terms (parts produce each other) and final terms (they ‘presuppose’ each other). Notice that denying top-down whole-to-parts, or nested causation does not preclude inter-level causation – on the contrary, inter-level causation is constitutive of closure of constraints: “What is frequently described as a causal action of the whole system on its own constituents, is in fact the result of the interaction among hierarchically organised constraints” (*ibidem*), as well as between constraints and processes. Accordingly, the whole organisation can indeed be said to be emergent without implying nested causation:

When a set of constraints realises closure, the resulting organisation constitutes a *higher-level emergent regime of causation*, possessing irreducible properties and causal powers. In particular, closed organisations are able to self- maintain as a whole (whereas none of the constitutive constraints can do it) which, in turn, enables them to generate biological *functions*. (20)

These irreducible causal powers are exactly those described by the unitary pluralist scheme described in section 4.1: we can ascribe material causation to processes and efficient and final causation to constraints only when organised in a self-determining network of dependencies (ivi, 10-11). For example, without self-determination, matter and energy would not be harnessed, and they would not constitute the organisation’s material causes.

As a result, the OA avoids the hypostatisation of the whole as *telos* or principle of the form and unity of the parts – it avoids referring to a design criterion for natural purposiveness. The whole *sensu* OA – as a causally pluralist network – is thus emergent on its components and condition of possibility of their causal differentiation. But because the organisational whole self-determines as a whole *through* and *as* the activity of its own parts, teleology is interpreted

in fully epigenetic terms. Organisational teleology is epigenesis without design – internal purposiveness *realised*.

Thus, if Kant’s antinomy depended on two different irreconcilable takes on the whole – as an empirical mechanical product, and as an ideal *telos* – the OA effectively overcomes the antinomy by showing how real, organised wholes, as described by closure of constraints, self- determine.

# §5 – An Epigenetic Interpretation of Design?

I have made the case that the OA succeeds in naturalising teleology through a reinterpretation of Kant’s epigenetic criterion, amended of its design aspects: self-organisation – now reinterpreted as self-maintenance of a regulated closure of constraints – does not need organisation – the presupposition of the whole as *telos*. As I anticipated at the end of section

§3, the regulated model gives us a picture of internally purposive biological organisation such that, in order to self-maintain, it ought to be open to changes in organisation – not simply in terms of morphology, but in terms of (functional) conditions of existence, of *telos*. Due to its role in mediating and shaping transitions between forms, regulation makes biological organisation not simply self-maintaining and adaptive, but truly *self-organising* in the Kantian sense – yet, without relying on the presupposition of an ideal organisation, a design, which self- productive activity is thought to bring about. I mentioned that this makes natural purposes truly ‘epigenetic’ in a Kantian but naturalised way.

As I have shown, the design and the epigenesis criterion perform different roles in Kant. Epigenesis shows us how each parts performs a function within the whole; but it is the idea of the whole, design proper, that provides “a norm […] to establish what a part (organ, trait, etc.) is supposed to do, and where a developmental process is supposed to go” (Huneman, 2017, 378; 2006). In contemporary terms, design makes intelligible the canalisation of all epigenetic processes as functional and purposive – for instance, how the apical epithelial cap and the blastema have the function of regenerating a lost limb in salamanders, or how imaginal discs have the function of developing into wings, legs, and antennae during metamorphosis in insects. Organisms do not just self-maintain, but they undergo different changes (material

turnover, regeneration, development) which are typically understood and explained as goal- directed towards the realisation of one or more determinate forms.

Evolutionary approaches, which centre design as an evolutionary product, have an easy job in explaining how forms are realised. Ontogenetic processes can be seen as a direct, mechanistic expression of design, perhaps embodied in a ‘genetic program’ (Mayr, 1992). The very ideas of ‘proper function’ or ‘having a function’ (as opposed to ‘performing a function’; Corti, 2022; Millikan, 1989) embody the very idea of an evolved normative design, in principle distinct from the organism’s concrete development and activity. In other words, evolutionary approaches reduce epigenesis to design (its ‘proximate’ teleonomic cause; Mayr, 1961), while taking design as a product of natural selection (its ultimate mechanistic cause). And while the ‘program’ seems to “play the role of ‘efficient cause’ and ‘final cause’ at the same time” (Vitale, 2022, 24), the organism’s *telos*, its design, is ultimately determined and shaped by something other than the organism itself, its evolutionary aetiology. In so doing, *the* central element of biological teleology identified by Kant is lost: its *intrinsic* nature, self-determination.

The OA performs exactly an opposite move. Recall the OA account of development proposed by Bich and Skillings (2024). Their work seeks to overturn the adultocentric view of development, where a later ‘mature’ reproducing form is the *telos* of earlier developing forms (ivi, 251), by proposing a view of development where the *telos* of each stage is the self- maintenance of the system (ivi, 259). This, in turn, can only be realised through regulated changes. We are now in the position to see how this involves centring epigenesis over design, self-maintenance over reproduction (ivi 257).[11](#_bookmark10) Yet, we can ask ourselves: how does regulation ‘know’ how the organisation ought to change, which developmental trajectory to take – which ‘design’ to follow?

Traditional views would rely on a notion of genetic program – or an analogous dispositional (Austin, 2015) principle for canalised ontogenesis – which expresses differently at different moments. The trajectories of development – growth, cell-differentiation, self- organisation proper – are already there, so to say, in potency, waiting to be expressed when the right activating developmental conditions are met, according to its evolved design / program (perhaps described by its evolved ‘norm of reaction’; Flatt, 2005; Oomen & Hutchings, 2022).

11 Evolutionary approaches see reproduction as an organism’s *telos* because it ensures the persistence of its design. The OA, however, may view reproduction as *telos* within the self-maintenance of a trans-generational organization (Mossio & Pontarotti, 2019; Saborido et al., 2011).

But this is not a line of reasoning available to the OA. Not only in an organisational perspective the causal role of the genome is on par with the other constraints – that is, it contributes to the goal of self-maintenance –, but the OA identifies the *telos* with present and changeable conditions of existence, not with the expression of a preformed or programmed principle. For the OA, ultimately, what is more originary is not a stable *telos*, but a plastic and radically epigenetic one, the changeable conditions of existence of a self-determining organisation. Indeed, organisms do display highly canalised and robust developmental / ontogenetic trajectories, which give the impression of a guiding program or *telos*. The OA does not deny that these trajectories are in some sense ‘shaped’ by evolution either. However, it understands their canalisation as the activity of *present* constraints, new or *inherited* – among which, the genome (Pontarotti, 2015, 2024) – which remain operative throughout an organism’s life, under regulation, but whose causal role is always contingent on the activity of the system as a whole.

By centring on the open-ended, epigenetic character of regulated self-organisation, the OA does not simply place itself in opposition to evolutionary or gene-deterministic approaches: it provides an effective *naturalising solution* to the very tension between design and epigenesis that animates Kant’s regulative stance. At the end of section §2 I have shown how for Kant the open-endedness of epigenetic processes – the ‘non-coincidence’ between the empirical and the ideal whole – is a problem which is solved at the transcendental level. To maintain an intelligibility granted by design, so to say, we trade the open-endedness of epigenetic processes for the open-endedness of our knowledge: the organism’s intrinsic lawfulness is a revisable epistemic norm, not a mutable property of the organism. For the OA, instead, this open- endedness, understood as the organism’s capacity to undergo regulated changes in organisation, is *constitutive* of and *essential* to its self-maintenance and self-determination.

In conclusion, we can see how the OA does not ignore the issue of form or design, that of the constraints imposed on the changeability of a system; but rather than taking it as the source of organismal teleology, it rather subordinates it to its self-determining activity – both at intra- and trans-generational scale. In so doing, not only it succeeds in naturalising biological teleology in fully epigenetic terms, but it lays the ground for an organisational, epigenetic interpretation of design. Design does indeed represent a ‘contrivance of parts’ that appears to us so essential to organism as to give the impression of being the contingent lawfulness of their epigenesis, that which distinguishes the ‘endless forms’ of realising self-organisation as they

have been shaped by evolution. If this is the case, then the OA also provides a naturalised framework of the role of organisation, intrinsic, natural purposiveness in shaping evolution.

Austin, C. J. (2015). The dispositional genome: primus inter pares. *Biology & Philosophy*, *30*(2), 227–246. https://doi.org/10.1007/s10539-014-9454-y

Barandiaran, X., & Moreno, A. (2006). On What Makes Certain Dynamical Systems Cognitive: A Minimally Cognitive Organization Program. *Adaptive Behavior*, *14*(2), 171–185. https://doi.org/10.1177/105971230601400208

Bich, L. (2018). Robustness and Autonomy in Biological Systems: How Regulatory Mechanisms Enable Functional Integration, Complexity and Minimal Cognition Through the Action of Second-Order Control Constraints. In *Biological Robustness. Emerging Perspectives from within the Life Sciences* (pp. 123–147). Springer. https://doi.org/10.1007/978-3-030-01198-7\_6

Bich, L. (2024a). *Biological Organization*. Cambridge University Press. https://doi.org/10.1017/9781009393959

Bich, L. (2024b). Organisational teleology 2.0: Grounding biological purposiveness in regulatory control. *Ratio*, *37*(4), 327–340.

https://doi.org/10.1111/rati.12405

Bich, L., & Bechtel, W. (2021). Mechanism, autonomy and biological explanation.

*Biology & Philosophy*, *36*(6), 53. https://doi.org/10.1007/s10539-021-09829-8

Bich, L., & Bechtel, W. (2022a). Control mechanisms: Explaining the integration and versatility of biological organisms. *Adaptive Behavior*, *30*(5), 389–407.

https://doi.org/10.1177/10597123221074429

Bich, L., & Bechtel, W. (2022b). Organization needs organization: Understanding integrated control in living organisms. *Studies in History and Philosophy of Science*, *93*, 96–106. https://doi.org/10.1016/j.shpsa.2022.03.005

Bich, L., Mossio, M., Ruiz-Mirazo, K., & Moreno, A. (2016). Biological

regulation: controlling the system from within. *Biology & Philosophy*, *31*(2), 237–265. https://doi.org/10.1007/s10539-015-9497-8

Bich, L., & Skillings, D. (2024). There Are No Intermediate Stages: An

Organizational View on Development. In M. Mossio (Ed.), *Organisation in Biology*

(Vol. 33). Springer.

Bickhard, M. H. (2000). Autonomy, Function, and Representation.

*CommunicationandCognition-ArtificialIntelligence*, *17*(3–4), 111–131.

Breitenbach, A. (2009). Teleology in Biology: A Kantian Perspective. *Kant Yearbook*, *1*(2009), 31–56. https://doi.org/10.1515/9783110196672.31

Christensen, W. D., & Bickhard, M. H. (2002). The Process Dynamics of

Normative Function. *Monist*, *85*(1), 3–28. https://doi.org/10.5840/MONIST20028516

Corti, L. (2022). The ‘Is’ and the ‘Ought’ of the Animal Organism: Hegel’s

Account of Biological Normativity. *History and Philosophy of the Life Sciences*, *44*(2),

17. https://doi.org/10.1007/s40656-022-00498-8

Corti, L. (2023). Organizational normativity and teleology: a critique. *Synthese*, *202*(3), 96. https://doi.org/10.1007/s11229-023-04255-7

Desmond, H., & Huneman, P. (2020). The Ontology of Organismic Agency: A Kantian Approach. In *Natural Born Monads* (pp. 33–64). De Gruyter.

https://doi.org/10.1515/9783110604665-003

Di Paolo, E. A. (2005). Autopoiesis, Adaptivity, Teleology, Agency.

*Phenomenology and the Cognitive Sciences*, *4*(4), 429–452. https://doi.org/10.1007/s11097-005-9002-y

DiFrisco, J., & Mossio, M. (2020). Diachronic identity in complex life cycles. In *Biological Identity* (pp. 177–199). Routledge. https://doi.org/10.4324/9781351066389- 10

Dresow, M., & Love, A. C. (2023). Teleonomy: Revisiting a Proposed Conceptual Replacement for Teleology. *Biological Theory*, *18*(2), 101–113.

https://doi.org/10.1007/s13752-022-00424-y

Flatt, T. (2005). The Evolutionary Genetics of Canalization. *The Quarterly Review of Biology*, *80*(3), 287–316. https://doi.org/10.1086/432265

Fulda, F. C. (2016). *Natural Agency: An Ecological Approach*. University of Toronto.

Fulda, F. C. (2017). Natural Agency: The Case of Bacterial Cognition. *Journal of*

*the American Philosophical Association*, *3*(1), 69–90. https://doi.org/10.1017/apa.2017.5

Gambarotto, A. (2023). Teleology and mechanism: a dialectical approach.

*Synthese*, *201*(5), 155. https://doi.org/10.1007/s11229-023-04137-y

Gambarotto, A., & Mossio, M. (2024). Enactivism and the Hegelian Stance on Intrinsic Purposiveness. *Phenomenology and the Cognitive Sciences*, *23*(1), 155–177. https://doi.org/10.1007/s11097-022-09823-9

Gambarotto, A., & Nahas, A. (2022). Teleology and the organism: Kant’s

controversial legacy for contemporary biology. *Studies in History and Philosophy of Science*, *93*, 47–56. https://doi.org/10.1016/j.shpsa.2022.02.005

Gardner, A. (2009). Adaptation as organism design. *Biology Letters*, *5*(6), 861– 864. https://doi.org/10.1098/rsbl.2009.0674

Garson, J. (2016). *A Critical Overview of Biological Functions*. Springer. https://doi.org/10.1007/978-3-319-32020-5

Garson, J. (2019). *What Biological Functions Are and Why They Matter*.

Cambridge University Press. https://doi.org/10.1017/9781108560764

Garson, J., & Papineau, D. (2019). Teleosemantics, selection and novel contents.

*Biology & Philosophy*, *34*(3), 36. https://doi.org/10.1007/s10539-019-9689-8

Ginsborg, H. (2001). Kant on understanding organisms as natural purposes. In E. Watkins (Ed.), *Kant and the Sciences* (pp. 231–258). Oxford University Press.

Ginsborg, H. (2004). Two Kinds of Mechanical Inexplicability in Kant and Aristotle. *Journal of the History of Philosophy*, *42*(1), 33–65.

https://doi.org/10.1353/hph.2004.0005

Ginsborg, H. (2006). Kant’s Biological Teleology and Its Philosophical

Significance. In G. Bird (Ed.), *A Companion to Kant* (pp. 455–469). Wiley Blackwell.

Haig, D. (2020). *From Darwin to Derrida: Selfish Genes, Social Selves, and the Meanings of Life*. The MIT Press. https://doi.org/10.7551/mitpress/12384.001.0001

Huneman, P. (2006). Naturalising purpose: From comparative anatomy to the

‘adventure of reason.’ *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences*, *37*(4), 649–674.

https://doi.org/10.1016/j.shpsc.2006.09.004

Huneman, P. (2014). Purposiveness, Necessity, and Contingency. In *Kant’s Theory of Biology* (pp. 185–202). DE GRUYTER. https://doi.org/10.1515/9783110225792.185

Huneman, P. (2017). Kant’s Concept of Organism Revisited: A Framework for a Possible Synthesis between Developmentalism and Adaptationism? *The Monist*, *100*(3), 373–390. https://doi.org/10.1093/monist/onx016

Huneman, P. (2024). Organisms: Between a Kantian Approach and a Liberal Approach. In M. Mossio (Ed.), *Organization in Biology* (pp. 127–157). Springer. https://doi.org/10.1007/978-3-031-38968-9\_7

Illetterati, L. (2014). Teleological Judgment: Between Technique and Nature. In E. Watkins & I. Goy (Eds.), *Kant’s Theory of Biology* (pp. 81–98). DE GRUYTER.

https://doi.org/10.1515/9783110225792.81

Jaeger, J. (2024). The Fourth Perspective: Evolution and Organismal Agency. In

M. Mossio (Ed.), *Organization in Biology* (pp. 159–186). Springer. https://doi.org/10.1007/978-3-031-38968-9\_8

Kant, I. (1790). *Critique of Judgment* (W. S. Pluhar, Ed.; 1987th ed.). Hackett Publishing.

Kauffman, S. A. (2000). *Inverstigations*. Oxford University Press.

Kreines, J. (2005). The Inexplicability of Kant’s Naturzweck: Kant on Teleology, Explanation and Biology. *Archiv Für Geschichte Der Philosophie*, *87*(3).

https://doi.org/10.1515/agph.2005.87.3.270

Letelier, J. C., Marı́n, G., & Mpodozis, J. (2003). Autopoietic and (M,R) systems.

*Journal of Theoretical Biology*, *222*(2), 261–272. https://doi.org/10.1016/S0022- 5193(03)00034-1

Lewens, T. (2007). “Functions.” In *HandbookofPhilosophyofBiology* (Elsevier, pp.

537–559).

Maturana, H., & Varela, F. (1980). *Autopoiesis and Cognition: The Realisation of the Living*. Reidel.

Mayr, E. (1961). Cause and Effect in Biology . *Science*, *134*(3489), 1501–1506.

Mayr, E. (1974). *Teleological and Teleonomic, a New Analysis* (pp. 91–117). https://doi.org/10.1007/978-94-010-2128-9\_6

Mayr, E. (1992). The Idea of Teleology. *Journal of the History of Ideas*, *53*(1),

117. https://doi.org/10.2307/2709913

Mayr, E. (1998). The Multiple Meanings of “Teleological.” *History and Philosophy of Life Sciences*, *20*, 35–40.

Menatti, L., Bich, L., & Saborido, C. (2022). Health and environment from

adaptation to adaptivity: a situated relational account. *History and Philosophy of the Life Sciences*, *44*(3), 38. https://doi.org/10.1007/s40656-022-00515-w

Millikan, R. G. (1989). In Defense of Proper Functions. *Philosophy of Science*, 288–302.

Minelli, A. (2011). Animal Development, an Open-Ended Segment of Life.

*Biological Theory*, *6*(1), 4–15. https://doi.org/10.1007/s13752-011-0002-6

Montévil, M., & Mossio, M. (2015). Biological organisation as closure of constraints. *Journal of Theoretical Biology*, *372*, 179–191.

https://doi.org/10.1016/j.jtbi.2015.02.029

Moreno, A., & Mossio, M. (2015). *Biological Autonomy: A Philosophical and Theoretical Enquiry* (Vol. 12). Springer Netherlands. https://doi.org/10.1007/978-94- 017-9837-2

Moss, L., & Newman, S. A. (2016). The grassblade beyond Newton: the

pragmatizing of Kant for evolutionary-developmental biology. *Lebenswelt. Aesthetics and Philosophy of Experience*, *7*.

Mossio, M., & Bich, L. (2017). What makes biological organisation teleological?

*Synthese*, *194*(4), 1089–1114. https://doi.org/10.1007/s11229-014-0594-z

Mossio, M., Bich, L., & Moreno, A. (2013). Emergence, Closure and Inter-level Causation in Biological Systems. *Erkenntnis*, *78*(S2), 153–178.

https://doi.org/10.1007/s10670-013-9507-7

Mossio, M., & Moreno, A. (2010). Organisational Closure in Biological Organisms. *History and Philosophy of the Life Sciences*, *32*(2–3), 269–288.

Mossio, M., & Pontarotti, G. (2019). Conserving Functions across Generations: Heredity in Light of Biological Organization. *The British Journal for the Philosophy of Science*, *73*(1), 249–278. https://doi.org/10.1093/bjps/axz031

Mossio, M., & Saborido, C. (2016). Functions, Organization and Etiology: A Reply to Artiga and Martinez. *Acta Biotheoretica*, *64*(3), 263–275.

https://doi.org/10.1007/s10441-016-9283-2

Mossio, M., Saborido, C., & Moreno, A. (2009). An Organizational Account of

Biological Functions. *The British Journal for the Philosophy of Science*, *60*(4), 813–841. https://doi.org/10.1093/bjps/axp036

Nahas, A., & Sachs, C. (2023). What’s at stake in the debate over naturalizing teleology? An overlooked metatheoretical debate. *Synthese*, *201*(4).

https://doi.org/10.1007/S11229-023-04147-W

Neander, K. (1991). Functions as Selected Effects: The Conceptual Analyst’s Defense. *Philosophy of Science*, *58*(2), 168–184.

Newen, A., De Bruin, L., & Gallagher, S. (Eds.). (2018). *The Oxford Handbook of 4E Cognition*. Oxford University Press.

https://doi.org/10.1093/oxfordhb/9780198735410.001.0001

Nicolis, G., & Prigogine, I. (1977). *Self-organization in nonequilibrium systems: From dissipative structures to order through fluctuations*. Wiley.

Oomen, R. A., & Hutchings, J. A. (2022). Genomic reaction norms inform

predictions of plastic and adaptive responses to climate change. *Journal of Animal Ecology*, *91*(6), 1073–1087. https://doi.org/10.1111/1365-2656.13707

Pontarotti, G. (2015). Extended inheritance from an organizational point of view.

*History and Philosophy of the Life Sciences*, *37*(4), 430–448. https://doi.org/10.1007/s40656-015-0088-4

Pontarotti, G. (2024). *Organization and Inheritance in Twenty-First-Century Evolutionary Biology* (pp. 219–240). https://doi.org/10.1007/978-3-031-38968-9\_10

Rama, T. (2024). The Explanatory Role of Umwelt in Evolutionary Theory: Introducing von Baer’s Reflections on Teleological Development. *Biosemiotics*. https://doi.org/10.1007/S12304-024-09569-8

Rosen, R. (1985). Organisms as Causal Systems Which Are Not Mechanisms: An Essay into the Nature of Complexity. *Theoretical Biology and Complexity*, 165–203.

https://doi.org/10.1016/B978-0-12-597280-2.50008-8

Rosen, R. (1991). *Life Itself : A Comprehensive Inquiry Into the Nature, Origin, and Fabrication of Life, Robert Rosen. 1991. Columbia University Press, New York, NY. 285 pages. ISBN: 0-231-07564-2. $45.00*. Columbia University Press.

https://doi.org/10.1177/027046769301300389

Ruiz-Mirazo, K., & Moreno, A. (2012). Autonomy in evolution: from minimal to complex life. *Synthese*, *185*(1), 21–52. https://doi.org/10.1007/s11229-011-9874-z

Saborido, C., & Moreno, A. (2015). Biological pathology from an organizational perspective. *Theoretical Medicine and Bioethics*, *36*(1), 83–95.

https://doi.org/10.1007/s11017-015-9318-8

Saborido, C., Moreno, A., González-Moreno, M., & Hernández Clemente, J. C. (2016). Organizational Malfunctions and the Notions of Health and Disease. In É. Giroux (Ed.), *Naturalism in the Philosophy of Health. History, Philosophy and Theory of the Life Sciences* (pp. 101–120). Springer, Cham. https://doi.org/10.1007/978-3-319- 29091-1\_7

Saborido, C., Mossio, M., Moreno Bergareche, A., & Moreno, A. (2011). Biological organization and cross-generation functions. *British Journal for the Philosophy of Science*, *62*(3), 583–606. https://doi.org/10.1093/bjps/axq034ï

Teufel, T. (2013). ‘Merely Mechanistic Laws’ – Causal Mechanism and Kant’s Antinomy of the Teleological Power of Judgment. In *Kant und die Philosophie in weltbürgerlicher Absicht* (pp. 261–270). DE GRUYTER.

https://doi.org/10.1515/9783110246490.4121

Teufel, T. (2014). The Impossibility of a “Newton of the Blade of Grass” in Kant’s Teleology. In *The Life Sciences in Early Modern Philosophy* (pp. 47–61). Oxford

University Press. https://doi.org/10.1093/acprof:oso/9780199987313.003.0003

Vitale, F. (2022). The The Teleological Program. Ernst Mayr’s Teleonomy from Philosophy to Cybernetics (or Kant’s Revenge). *Aisthesis. Pratiche, Linguaggi e Saperi Dell’estetico*, *14*(2), 17–28. https://doi.org/10.36253/Aisthesis-12754

Walsh, D. M. (2015). Organisms, Agency, and Evolution. In *Organisms, Agency, and Evolution*. Cambridge University Press.

https://doi.org/10.1017/CBO9781316402719

Walsh, D. M. (2017). *“Chance Caught on the Wing”* (Vol. 1). Oxford University Press. https://doi.org/10.1093/oso/9780199377176.003.0008

Walsh, D. M. (2018). Objectcy and Agency. In D. J. Nicholson & J. Dupré (Eds.), *Everything Flows: Towards a Processual Philosophy of Biology* (pp. 167–185). Oxford University Press. https://doi.org/10.1093/oso/9780198779636.003.0008

Weber, A., & Varela, F. J. (2002). Life after Kant: Natural purposes and the

autopoietic foundations of biological individuality. *Phenomenology and the Cognitive Sciences*, *1*(2), 97–125. https://doi.org/10.1023/A:1020368120174

Wolfe, C. T. (2024). Varieties of Organicism: A Critical Analysis. In M. Mossio

(Ed.), *Organisation in Biology* (pp. 41–58). Springer. https://doi.org/10.1007/978-3-031- 38968-9\_3

Zammito, J. (2006). Teleology then and now: The question of Kant’s relevance for contemporary controversies over function in biology. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical*

*Sciences*, *37*(4), 748–770. https://doi.org/10.1016/j.shpsc.2006.09.008