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Jurisgenerative Tissues: Sociotechnical Imaginaries and the Legal Secretions of 3D Bioprinting

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Introduction

Engineers and bio-scientists are developing 3D-bioprinters that produce living, human organs and tissues that can be surgically implanted in patients for therapeutic use. Like tissue engineering and regenerative medicine generally, 3D-bioprinting potentially disrupts experience of the human body by redefining understandings of, and becoming actualised in new practices and regimes in relation to, the body (Kellett 2018; Shildrick 2012; 2015). Such disruptions may have consequences for legal-theoretic understandings of the body. In conventional literature on the procedure's bioethical and legal qualities and implications, this has included reference to a potential democratising promise, much like 3D-printing generally, of redistributing manufacturing capacities and increasing supply of otherwise scarce resources (Vermeulen et al. 2017). But the significance of 3D-bioprinting to law and legal theory may be more fundamental than that. Technological processes like 3D-bioprinting may shape how humans encounter and experience social and physical worlds, including law, at the level of ontology.

To make sense of the potential effects of 3D-bioprinting on law and legal theory, legal theorists may benefit from looking to critical science and technology studies (STS). For example, STS scholars, especially Sheila Jasanoff, have conceptualised the ontological mediations of technology through the concept of sociotechnical imaginaries. Sociotechnical imaginaries are 'collectively imagined forms of social life and social order reflected in the design and fulfillment of […] scientific and/or technological projects' (Jasanoff and Kim 2009, p. 120). These imaginaries emerge from 'assemblages of materiality, meaning, and morality' mediated through technology or technological projects, and 'encode not only visions of what is attainable through science and technology but also of how life ought, or ought not, to be lived' (Jasanoff 2015a, p.

4). STS scholars have previously considered law's constituency in sociotechnical imaginaries; such scholars have thought through how law affects practices involving technology (Jasanoff 2015b; Tessaro 2020), 'elevate[s] some [imaginaries] above others' (Jasanoff 2015a, p. 4), and how legal orders become possible (or impossible) and realised (or unrealised) through imaginaries that define and legitimise certain relations, particularly as those affect 'the management of life' (Hurlbut et al. 2020, p. 1106; Karpin and Mykitiuk 2021). Three-dimensional bioprinting may thus introduce a novel sociotechnical imaginary and the opportunity for different legal orderings.

To consider the potential of 3D-bioprinting requires the legal theorist to observe how law, society and technology specifically act on and create change in each other. Jasanoff (2015a) and colleagues (Goulet 2020) have lately acknowledged that a plurality of sociotechnical imaginaries can exist concurrently, in tension or complementarily. But, even then, STS scholars tend to relate sociotechnical imaginaries to law in an over simplified way, treating such imaginaries as 'large, structural edifices with the persuasive power of creating and supporting socially endorsed institutions, policies, laws, and practices' (Karpin and Mykitiuk 2021, p. 12). In actuality, these imaginaries are 'constructed and reformed, contested, resisted, and understood' (Karpin and Mykitiuk 2020, p. 12) with far greater heterogeneity at the margins of, outside, between, inside and through ontological frames. In the midst of these competing frames, micro practices pertaining to technology produce perturbations or creative re-combinations of imaginaries held among everyday individuals, which have the potential to 'play a role in influencing action and material "outcomes"' (Karpin and Mykitiuk 2021, p. 7) like imaginaries entwined with the state. These actions and outcomes not only resist authoritative imaginaries succoured by the state, but also possess, and generate, alternate norms and values that can take the form of a legal community, to the extent the social and physical world engendered matter to the ordering and legitimation of

social relations. As this applies to biotechnology, micro practices that upend authoritative sociotechnical imaginaries might potentiate different legal understandings and cultures of the body, health and disabilities (Karpin and Mykitiuk 2021), and change in law and regulation.

Jasanoff and colleagues (Hurlbut et al. 2020) also appear to presume a certain stability to the human body, whilst acknowledging the body's appearance or significance as malleable to sociotechnical imaginaries. But, as corporeal, material feminists have argued, the body is unstable and porous provisionally expressed in time and place (Alaimo 2010). Further, the body enjoys a certain recalcitrance that resists its social construction and shapes its representation (Grosz 1994; Mykitiuk 1994). Holding close these feminist insights, sociotechnical imaginaries mediated by biotechnology might also be 'constructed and reformed, contested, resisted, and understood' (Karpin and Mykitiuk 2021, p. 12) through the micro practices *of* our bodies. By this, we mean, instead of treating the body as merely a surface upon which sociotechnical imaginaries and their regulatory forms are inscribed, the body becomes an expressive materiality with capacities—physical, physiological, social, or otherwise affective—that matter in some way to other objects, bodies or environs, becoming a constituent element of the assemblages from which sociotechnical imaginaries emerge. Like the micro practices of individuals using biotechnology (Karpin and Mykitiuk 2021), the *bodies* encountered by biotechnology may also then shape sociotechnical imaginaries and the sociolegal phenomena made possible through such imaginaries, at least to the extent such phenomena relate to the body. In other words, how the body affects or is affected by biotechnology might generate different legal understandings and regimes of the body, and result in change to law and regulation.

Few legal scholars have considered the micro practices of the body in relation to the formation of law and legal meanings (Dietz et al. 2020); to our knowledge, fewer scholars have

considered how bodies' micro practices, in encounter with biotechnology, might contribute to the sociotechnical imaginaries that construct and effect what is possible, including law and regulation (Grear 2018; Pottage 2007). This inattention in theoretical scholarship motivates our intervention here. We consider the process of 3D-bioprinting as a case-study to explore how the body in encounter with biotechnology might re-constitute sociotechnical imaginaries, and the legalities and regulation those imaginaries support and depend upon. We draw on new materialist and post-phenomenological literatures on technology and the body, which allow us to attend to law's relations to sociotechnical imaginaries without losing hold of the nuanced deviations, resistances and proliferations that are formative to such relations and may matter in experience. Instead of treating sociotechnical imaginaries and their modes of governance as impenetrable, unchanging 'structural edifice', we treat both as dynamic, open processes capable of continuous movement, tension, decomposition, re-composition and transformation in a panoply of directions. Attention to the processual qualities of sociolegal phenomena may not always have analytical purchase. However, we advance an embodied legal theory that can account for these processual qualities—can account for the micro practices of the body, of corporeal matter, of technology that continually subtend, exceed and transform individualised sociolegal forms—for situations where it makes a difference to social action. The process of 3D-bioprinting may be one such event for which this legal theory can make a difference.

First, we describe the micro practices of ontogenesis and the proliferating, ontological possibilities of bodies and their constitutive parts or matters; second, we consider these ontological productions as intricately entwined with legal meanings in the sense that the ontogenetic entails the transformation and re-ordering of sociolegal relations; and, third, we push past the speculative renderings of 3D-bioprinting which brim with explosive wonder (De Lucia 2020) and consider the

legal regimes that 'in-form' (Simondon 2020) the process (in terms of printing and its therapeutic applications) and constrain the sociolegalities that 3D-bioprinting effects. In effect then, we describe multiple, possible imaginaries—the speculative, radical imaginary where ontogenesis proliferates, in encounter with an imaginary bridled by power. We then conclude reflecting on the material, spatial and embodied legal theory advanced here, particularly as it grapples with the recalcitrance of the body and the contribution of that recalcitrance to sociotechnical imaginaries.

Ontogenesis of flesh

Our investigation into 3D-bioprinting (and the sociotechnical imaginaries such technology mediates) is assisted by attending to the micro practices of bodies and corporeal matter which contribute to generating new ways of being or ontologies. Thinking with Gilbert Simondon (2020), and corporeal, material feminists who have also thought with Simondon (Grosz 2012; 2017; Manning 2010; 2013), we locate this ontogenetic capacity in the ongoing 'individuations' that compose and are affected by bodies and corporeal matter.

Simondon (2020) contrasted individuation with the individual. Individuation is the process by which an individual object, form or entity is made, whilst the individual is the ephemeral artefact resulting from that process. For Simondon (2020), the material world has no pre-constituted individual forms; all matter, living and non-living, exists in the middle of ongoing processes that condition the emergence of individuated forms. Further, no individual form exhausts the potential of individuation; the individual is preceded and exceeded by forces (what Simondon refers to as 'pre-individual' forces) that propel, or retain the potential to propel, further individuations. The potential to individuate resides in the constitution of every object, form or entity, which belies our understanding of a given object, form or entity as complete or whole

(Lapworth 2016). Individuation provides for the emergence of familiar forms as well as a bountiful potential for new ontological possibilities in the encounter and tension of pre-individual forces, especially, as Simondon (2020) notes, in our encounter with technology.

Along similar lines, corporeal, material feminist scholars have argued the human body is not a stable metaphysical being, nor is it materially enclosed as Western, masculine representations of the body presume; rather, the body is an expression of materials that repeatedly fold in together and interact, temporarily articulating forms we come to experience and recognise as an individual's one, continuous body (Alaimo 2010; Bray and Colebrook 1998). The body does not have any clear overarching plan or system of meaning that reliably identifies and makes sense of bodily differentiation (Bray and Colebrook 1998, p. 58). Instead, the body is the provisional effect of 'connections made among [other] bodies', as well as other matters, situationally realised in the context of an event (or better put, a plurality of events) (Bray and Colebrook 1998, p. 58). In other words, bodies are body-events which are 'capable of infinite connections and variations' (Bray and Colebrook 1998, p. 57). Further, connections between matter not only condition the body's expression but also potentially transform the constituent materials, so that the body cannot merely correspond to the summation of material parts. The body's constituent materials are themselves temporary, volatile and prone to assuming novel qualities, allowing a porosity to the human body that can dissolve any reliable distinction between it and the physical and social environment, whilst providing the specific conditions of a body's articulation (Alaimo 2010).

The human body exists only in the process of it becoming a body (Manning 2010; 2013). Erin Manning (2010; 2013) goes so far as referring to the body as movement; the body is always moving, always becoming through movement, always exceeding itself in the action of *bodying*. This processual quality extends to the constituent materials that compose the body (Grosz 2017).

Even a purportedly stationary body, like the body of a person who is bedridden, moves, in that corporeal matter (organic, molecular, atomistic) exists dynamically in a vibrant ecology beneath and beyond the appearance of skin. Indeed, skin itself is not a static membrane; it undergoes constant transformation at the scale of the cell. The body never stops moving; the duration of the body's movement potentiates the next movement in an unending choreography propelled by the incipiency of the body's virtuality (or 'biogram') (Manning 2009). This movement does not originate in consciousness; nor can it be fully controlled or regulated by a knowing mind. The body's biogram emanates from the pre-conscious effect of affective connections brought together through the articulation of the body, which render certain directions, comportments or gestures possible (Manning 2009).

Manning (2010; 2013) conceptualises the body as more-than-one. She understands the articulated body (the *one*) incapable of accounting fully for the constituent materials that fold in together and interact (the *more*) to condition the body's emergence (Manning 2010; 2013). The body always potentiates more than what is articulated in a given moment. The biogram is not exhausted by the body that is produced in movement, nor is it impervious to new affective connections. As more-than-one, biograms are open processes that harbour potentially infinite bodies, allowing for transformation in a body's movement (Manning 2009) and new ontological possibilities for the body and surrounding milieu (Manning 2014). Similarly, Elizabeth Grosz (2012; 2017) argues that the individualised body is preceded and exceeded by forces that condition its actualisation and future transformation. The body's actualisation is a phase, 'engendered, prompted by instability, and is itself a reordering at a different level and in a different manner of instability' (Grosz 2012, p. 39). The process of individuating a body is a mediation between conflicting forces that precede and exceed the body. The resulting 'disparation' between forces

(Grosz 2012, p. 42) is overcome through a creative, 'transductive' movement that transforms, and re-orders, those forces so that the body is actualised as a metastable condition of potentials temporarily (re)distributed in a field (Grosz 2012, p. 43).

All matter is understood by Manning (2010; 2013), Grosz (2012; 2017) and Simondon (2020) to be the provisional effect of such individuations. But the living body is distinct in that it 'is a system of individuation, an individuating system and also a system that individuates' (Simondon quoted in Grosz 2017, p. 182), whilst for non-living matter its individuation 'may be effected through a single encounter' (Grosz 2012, p. 47). Living bodies are comprised of ever-complexifying folds, processes and movements—such as with molecules, tissues, organs and physiological systems, among other corporeal matter—which proliferate interiorities and milieus. The proliferation of interiors and milieus within and beyond the living body generates further, increasingly involuted individuations previously incapable of actualisation (Grosz 2017). In this way, bodies are endlessly productive of different orders or kinds of individuations than is possible in the absence of biological life, such as the collective individuations constituted in social and cultural life (Grosz 2017). A different spatio-temporality to matter is made possible through the ontogenetic capacities of biological life (Grosz 2017): an *ontogenesis* of flesh through which ontologies are mediated through the intercorporeal encounters between bodies, and bodies and things.

Ontogenesis of the flesh is proliferated through the encounter of biological life and technology. Simondon argued technology has 'the capacity to force new and unexpected connections of modes of thought, vital bodies, technical objects and energetic milieus' (Lapworth 2016, p. 126). Technology does so through the process of individuation, 'produc[ing] new material sensibilities [that can] invent new potential forms of life' (Lapworth 2016, p. 126). With

biotechnology, this can involve the 'taking-form' of material, organic individuations hitherto unencountered outside imagination (Lapworth 2016), even at the scale of producing cheese from microorganisms or the domestication of animals (Verma et al. 2011). There is a 'challenging and subverting [of] normativities and "fixed" divisions' (Radomska 2020, p. 123) of materiality, accentuated in the encounter between biological life and technology that allows new capacities to individuate, becoming incorporated into the world through a proliferating cascade of ontogenesis.

Effects of ontogenesis can also extend to the individuation of 'technical mentalities' (Simondon 2020) among communities, 'emerg[ing] immanently from our affective experience of, and material encounters with, different technical objects' (Lapworth 2020, p. 112). This is a 'collective individuation' among social groups 'that infus[es] technical networks, subjects, (organic and nonorganic) bodies and the relations between them' (Lapworth 2020, p. 112). These mentalities become sedimented in institutional forms of life, materialised in social performance, which set up further individuations that continually remake the ontological horizons of what is possible. Technical mentalities thereby contribute to 'utopias' or futures imagined and mediatised through the use of and encounter with technological objects, reconfiguring social life (Dickel and Schrape 2017, p. 54-55). In this way, Simondon's (2020) concept of technical mentalities anticipates the thesis of co-production advanced by Jasanoff (2015a) through the concept of the sociotechnical imaginary, albeit with more attention to the technicity, or micro practices, engendered in the encounter between life and technology (Feenberg 2017). Whilst these concepts do not appear to have been discussed alongside each other before, we understand technical mentalities as a part of sociotechnical imaginaries, to the extent they both parse the material-discursive configurations of society as mediated by technology.

The ontogenetic encounter of biological life and technology is exemplified in instances of bio-art, such as that of Oron Catts' and Ionat Zurr's *Tissue Culture and Art* (TC&A) project (Lapworth 2015). One exhibition from the project, *Victimless Leather*,[1] involves chimeras, in the sense of hybridised tissue that combines cell lines across species and, in some instances, kingdoms, whether intentional (the combination of 3T3 mice cells and human bone cells) or not ('infection' by fungi) (Radomska 2018). Each production of bio-art varies in design and implementation; however, in adapting technologies of synthetic biology, bio-art tends to challenge prevailing representations of the body as bounded, delineated from others and necessarily human or otherwise familiar (Kellett 2018). Synthetic biology is adapted to frame and produce the sensation of biological life as monstrous, estranged or mystifying materialisations through creative combinations of tissues, or manufacture of living tissue in unrecognised forms, forcing phenomenological experience outside the security of one's 'self' (Kellett 2018; Radomska 2018). In doing so, these examples of bio-art rely on formal qualities as opposed to its represented content to disturb and remake relations between bodies, creating or emphasizing ontological liminality (Kellett 2018). In the case of the Tokyo exhibition of *Victimless Leather*, Marietta Radomska notes the chance encounter of fungi and the jacket's intended form 'evokes a wider sense of entanglement between life and waste revealed through somatechnological mechanisms: how that which has been disposed of influences the bodies of both a human and a non-human kind; and how the distinction between things and processes that are deemed to be "life," and those that are abundant and disposable, becomes blurred' (2018, p. 221). Andrew Lapworth argues that bio-art like the TC&A project achieves this through 'creatively experiment[ing] with the possibilities for alternate relations of thought, vital matters and biotechnologies, generating new capacities for

[1] The description is provided on the website for the Tissue, Culture and Art Project, https://tcaproject.net/portfolio/victimless-leather/.

thinking and perceiving the different gradients of life that surround and constitute us' (2016, p. 124). This is an imperfect, provisional expression of individuations, produced from intentional and unintentional affectations of vibrant matter (Bennett 2010; Lapworth 2016).

Three-dimensional bioprinting can similarly be thought of as an assemblage of somatechnological events through which biological life and technology are brought into repeated, radical encounter. The 3D bioprinter is a machine by which the body and corporeal matter are de-phased and re-phased into new forms through the composition of bio-ink, coded instructions and the resulting 'additive manufacture' (the process of printing materials by adding layer upon layer) of living tissue.[2] Each separable component of the process implicates individuations by which an ontogenesis of the flesh may be broadly permitted, allowing splices in the engineering process that produce difference in the tissue from that which it is derived. As synthetic biology generally has promised, these splices may be desired to the extent they address a malady or the risk of such (Kent et al. 2006) or, assisted through the imaginative potential of science fiction, the invention of new biological capacities. The ontogenetic capacity of 3D-bioprinting may be unintended as well. Tom Roberts (2017) argues that the 'blueprint' or coded models required for additive manufacture are like the clay and mould in Simondon's example of making a brick: we may be tempted to see 3D-printing through the prism of hylomorphic technologism, where a clear subject-object relation exists in that the human engineer is the sole, deliberate author of the design that is imposed upon otherwise inert matter; however, pre-individual forces that subtend the individuations of code, substrates and scaffolds contribute expressively to the process of individuating the 3D-printed

[2] Standing Senate Committee on Social Affairs, Science and Technology, *Challenge Ahead: Integrating Robotics, Artificial Intelligence and 3D Printing Technologies into Canada's Healthcare Systems* (Ottawa: Senate of Canada, 2017), online: https://sencanada.ca/content/sen/committee/421/SOCI/Reports/RoboticsAI3DFinal_Web_e.pdf, at p. 6; a description of bioprinting can also be found on the Alevi Blog, *What is 3D Bioprinting*, published online on October 22, 2020: https://www.allevi3d.com/what-is-3d-bioprinting/.

object (Roberts 2017). Roberts (2017) argues that 3D-printing is in fact an inevitably contingent process, as all individuations are, which defy the purported dominium of human agency by incorporating the affects of vibrant, non-human or more-than-human materiality. Three-dimensional bioprinting would incorporate similar contingencies.

But an important distinction must be made. The 3D-printing concerning Roberts (2017) involves non-organic materials that, following Simondon (2020), seldom propagate more than one individuation unless technologically mediated (Grosz 2017). Relative to 3D-printing generally, 3D-bioprinting may be thoroughly ontogenetic in that biological life is directly implicated in the process of printing, which, through Grosz (2012; 2017), Manning (2010; 2013) and Simondon (2020), we can appreciate is already especially expressive, enduringly individuating for as long as the distinguishing properties of organic life—'as a system of individuation, an individuating system and also a system that individuates' (Simondon quoted in Grosz 2017, p. 182)—are sustained. The somatechnological events of 3D-bioprinting may radicalise corporeality even more to the extent relational economies of individuations and milieus sustaining biological life are reconfigured, individuating novel, material vibrancies.

The emergence of novel, material vibrancies through 3D-bioprinting, like bio-art, may be consequential to the individuation of technical mentalities among communities, which, as noted above, 'emerge immanently from our affective experience of, and material encounters with, different technical objects' (Lapworth 2020, p. 112), and the sociotechnical imaginaries such mentalities support. Technical objects are understood here to include somatechnological events like those engineered through 3D-bioprinting. We now turn our attention to how such imaginaries may emerge, with particular care for the contribution of law and legal phenomena.

Jurisgenerative matter

How 3D-bioprinting may matter to law and legal theory can be explored speculatively by considering the consequences a radical, corporeal ontology may have in the active making of law; by considering how bodies and corporeal matter are intricately entwined with the production of legal order and meaning (Philippopoulos-Mihalopoulos 2015) and that 3D-bioprinting, to the extent it mediates ontogenesis with the body, may transform and re-order sociolegal relations. Such exploration necessitates a material, spatial and embodied legal theory alive to the relation of bodies to law. Specifically, we advance a legal theory that can account for the processual qualities of sociolegal phenomena— one that can account for the micro practices of the body, of corporeal matter, and of technology that continually subtend, exceed and transform individualised sociolegal forms—which will ultimately aid in describing the case of 3D-bioprinting and the sociotechnical imaginaries it instantiates. This requires us to '"incorporate" embodiment into [legal] discourse' (Mykitiuk 1994, p. 98) by reaching beyond the conceptualisation of law as the negation of the body through regulation and control and, instead, to consider how embodiment is already formative to law (Travis 2014) including how different forms of embodiment may secrete new senses of the legal (Ahmed 1995; Dietz et al. 2020; Gilani 2020; Mykitiuk 1994; Shaw 2020).

The body as a positive, formative force to law surfaces in select theoretical tracts. For example, Bernard Hibbitts (1995) considers the import of gesture to law as an embodiment of legal meaning; a means of mediating legal relations through bodily contact, comportment and movement, which has largely been estranged in modern legal systems in the prioritisation of written texts. His account of legal gesture presents embodied performance as 'a powerful and sophisticated modality which can perform—and historically has performed—a wide range of indicative, ordinative, evidentiary, demonstrative, mnemonic, communal, regulatory, and

psychological functions' for law (Hibbitts 1995, p. 72). Peter Goodrich (2000, p. 265) refers to legal somatics, through which legal meaning emerges creatively, personally and, importantly, *immanently* in 'techniques of embodiment' that concretise law. Law is 'expressed through the corporeal figure' (Goodrich 2000, p. 263), not merely through the capacity of legal institutions to 'arrest […] the body' (Goodrich 2000, p. 263) but also in 'the unconscious or habitual body of the subject, […] the somatics of repetition and the traces that [such performances] leav[e]' (Goodrich 2000, p. 264). Sean Mulcahy (2021) relatedly argues that the dancing body, as a particular mode of legal somatics, is inventive of legal relations between bodies and environs, human and non-human, and potentially the basis of an embodied method that could reconfigure legal relations (Shaw 2020).

The body appears beyond legal gesture, as well, as something both kinetic and carnal, material and immaterial, where legal meaning gushes forth from someplace deep in the flux of flesh meeting flesh. For example, Sara Ahmed (1995) notes the centrality of the white, male body—a white, male body of the 'Law' concealed through dis-embodying fictions—and the creation of the racialised, female 'Other' in the constitution of legal relations. Against the Law's dis-embodying fictions, Ahmed reconstructs rights as fundamentally a problem of power between bodies—bodies that desire, consume, fear, love, etc.—which may, if disrupted through attention to 'embodiment as a process, at once temporal and historical, both institutionally de-limited as well as performatively inventive' (Ahmed 1995, p. 69), reconfigure law toward 'an alternative inscription' (Ahmed 1995, p. 69). Similarly, Alain Pottage considers how 'passion extends a surface of "mucosity"' (1995, p. 141) which not only succours 'the development of a sexed subjective identity […] [but] is also the medium of an intersubjective flux of passion' (Pottage 1995, p. 137), a basis for the fabrication of an alternative law in the thickening folds of embodied

desire. Pottage (1995) argues that this sense of the legal emerges immanently from the materiality and immateriality of real bodies, even prior to the inscription of the Law, which, like Ahmed, he sees as a potential source for living law differently. Or, as Victoria Brooks puts it, law can be 'situat[ed] […] in the multitude of affects produced by bodies and […] space' (2014, p. 293). Whilst the Law principally operates as system that evaluates the effects of bodily encounters, a countervailing attention to the affectivity of bodies may fragment the incorporeality of Law that often sits atop and transduces the bodies it regulates, invigorating openness, instability and difference in legal relations (Brooks 2014).

An embodied legal theory thereby forces the scholar to encounter the ontological relation of the body or bodies to law (Dietz et al. 2020), with especial attention to the space and temporality of law's expression. But with 3D-bioprinting it becomes necessary to take a closer look at the bodies implicated in the production of law and legal phenomena, as the technology not only involves the bodies of the individual patient (prior to, in anticipation of and after therapy), but also the corporeality of the printed matter: the synthetically engineered organ or tissue. Taking a closer look at the law or legal phenomena embodied in corporeal matter is to encounter ever-complexifying ontological relations, which necessitate adaptations to legal theory to sense, and make sense of, such relations. To account for how corporeal matter is grafted in law, and law in corporeal matter, we must move beyond the human body as an autonomous or even relational subject, to the tangle of folds, processes and movements—as molecules, tissues, organs and physiological systems, among other corporeal matter—which may take-form in the articulation of a body and exist in relation to broader biological, social and environmental ecologies (Philippopoulos-Mihalopoulos 2015; Shaw 2020; 2021). Like David Delaney describes with respect of pharmaceuticals, we argue that 'traces of legal meaning are often *literally* constitutive

of the materiality […] at the molecular level' (emphasis in original) (2019, p. 6), and *vice versa*. Law is not a passive, reactive environment that merely regulates inventions of biotechnology from outside the process of material, technological creation (Delaney 2019). Indeed, as Delaney continues, '[i]f one could magically remove "the legal" from […] molecules, they might not exist as material entities at all' (2019, p. 16). Further, this entails a move toward a processual understanding of the body and sociolegal relations (Gilani 2020; Shaw 2021), where both embodiment and legal meaning are individuations, themselves the consequence of an ecology of individuations, and not pre-constituted phenomena.

From this theoretical position, legal embodiment is constituted immanently through individuations of corporeal matter. In the process of individuation, pre-individual forces that compose corporeal matters redistribute disparately, resulting in affective tension between those forces. This disparate field of tensions portends the disassembly of matter, but it also potentiates, and is resolved through, events of 'transduction' (Simondon 2020) by which interiorities and exteriorities of a new ontological order are articulated at an order above and in place of the chaotic field from which such transductions are generated (Grosz 2017; Simondon 2020). In this way ontological order takes form and reforms through iterative events of disparation and transduction; immaterial ruptures that come from the flux of tensions that form an ontogenetic frame (Grosz 2008). Legal normativity and meaning form part of those pre-individual forces, inclusive of the affectivity of organic, molecular and atomistic forces, which potentiate the individuation of embodied legal performance. They in-form the expression of the individuation process, like any pre-individual force, albeit often with greater measure owing to the strength of institutionalised, power relations. Specifically, the movement of pre-individual forces form interior and associated milieus, ordered in such a way that legally charged, corporeal movements are individuated—a

cascade of movement potentiating movement (Manning 2010; 2013)—like the breath, heartbeat and kicks of a 'brain dead' patient that simultaneously individuate as legal gestures of life, despite medico-legal judgements to the contrary (Shaw 2021).

In other words, borrowing from Andreas Philippopoulos-Mihalopoulos (2015; 2020), law *is* space composed of the affective intensities—broadly understood as forces capable of affecting, and being affected by, other intensities—which stage, regulate and give meaning to movement and experience. A lawscape—the inextricable tangle of law and space, and law and matter that 'unfolds as difference' (Philippopoulos-Mihalopoulos 2020)—emerges from the middle of this open flux of affective intensities, mediated by an ever-shifting distribution of affects or pre-individual forces that take-form, re-form and un-form organic life. Each movement of corporeal matter, no matter its scale, *lawscapes* through individuation in the composition of space (Grear 2017; Philippopoulos-Mihalopoulos 2015). Three-dimensional bioprinting may also be lawscape to the extent the process fragments and recomposes corporeal matter in novel, creative configurations, proliferating legally charged, corporeal movements in space.

The ontogenetic capacities of 3D-bioprinting may also be characterised as brimming with wonder (De Lucia 2020). Vito De Lucia (2020, p. 340) describes wonder 'as a mode of encountering the world […] premised on relational diversity' (emphasis removed) where 'knowing does not happen from a centre, but in the middle of the world—in fact in the middle of a relation' (De Lucia 2020, p. 345). Wonder is a state of becoming immanently *with* the natural world, dazzled and de-centred in the thick of it, but groping searchingly through relations found through embodied sensations. Manning similarly describes the body in movement '*wondering* the world' (our emphasis) (2014, p. 172), where the incipiency of biogram—the virtuality of the body that potentiates movement (Manning 2009)—is fullest, reaching beyond where the body is presently,

allowing new qualities to movement to take-form. Wonder is both a space of estrangement and emergence in embodiment that together allow new capacities. We can supplement De Lucia's (2020) and Manning's (2014) accounts by thinking of wonder in the case of the 3D bioprinter as an artistic mode; wonder 'de-frames' and enframes bodies, composing sensations that mediate bodies' relations to their milieus (Grosz 2008, p. 13), not from a vantage point separate from and external to the world but in the flux of it. In alternating movements between de-framing and framing, wonder-full events metabolise, transform and compose sensations in encounter with chaos, as a means to 'elaborat[e], produc[e] and intensif[y] affects and percepts' (Grosz 2008, p. 27).

De Lucia situates a method of natural law 'precisely in the encounter of wonder-full relations' (2020, p. 343), where '[t]he good [law] lies […] in a (set of) relation(s): in the gaps and the differences that relation bridges but does not eliminate; in ways of knowing; and in ways of acting that reflect the (dispositional) naturalness of/in the world' (De Lucia 2020, p. 345). In other words, 'good' law (as opposed to 'true' law) is found in the context of a particular place and temporality, in affective connection between bodies in wonder-full encounter; or, again to return to Grosz (2008), composed in 'bring[ing] together a series of disparate elements' (Grosz 2008, p. 56) to create sensations, rhythms, vibrations from the intensification of bodily desire (Grosz 2008, p. 69). Such encounters briefly estrange us from the world to saturate our search for better footing among difference or tensions we come up against, not from the centre preoccupied with coercive control and order; rather, in an aesthetic or artistic mode that negotiates and creates, provisionally and relationally from within the thick of our bodied, lawscaping dispositions. This is potentially a mode of jurisprudential encounter where legal difference is concretised through dynamic, playful movements within and between corporeal matters (Shaw 2020).

Like fungi affecting *Victimless Leather*, the playful, transcorporeal entanglements produced through 3D-bioprinting potentially rend the fabric of extant sociolegal relations, allowing new legal orders and meanings to show through. Depending on the extent of the tear and how the emergent orders and meanings are taken up in their social and physical milieu, sociolegal relations may be mended over to look much as they did before or patched like a technicolour quilt drawing on the myriad of pre-individual forces that subtend, exceed and proliferate living forms. Our choice in responding to this ruptured lawscape—in our determinations of what to bioprint or how we engage the materials individuated through such a process, among other relevant judgements—involve ethico-onto-epistemological cuts informed through the materio-corporeal expressions that affect (and constitute) us (Grear 2017; Philippopoulos-Mihalopoulos 2015). These wonder-full events may induce a sense of responsibility, or its dereliction, in newfound attention to how the human, non-human and more-than-human *matter* (De Lucia 2020; Grear 2017). In this way, the lawscape may emerge from bioprinted materials, known or unbeknownst to the community that encounters such jurisgenerative matter, in the tumult of matters, discourses, objects, etc. that come together provisionally, creating legal difference.

Printing with biopolitical ink

Claire Horn and Elizabeth Chloe Romanis (2020) remind us to take care not to become unmoored from reality in the generative, imaginative space of speculative scholarship. Writing about ectogenesis, Horn and Romanis (2020) argue that speculative thought is always situated, engendered under conditions here and now that suffuse the scholar's vision of the future despite the relative freedom fiction ostensibly allows. Accordingly, scholars must account for such conditions in speculative thought, both in terms of the scholar's standpoint and the plausible

context in which biotechnology will emerge (Horn and Romanis 2020). Whilst plausibility, like any observation, is inevitably a thoroughly normative or otherwise evaluative judgement—an ethico-onto-epistemological cut (Grear 2017)—reflexive consideration better ensures speculative thought is responsive to the social reality under which that future may be realised. Similarly, despite the promise of 3D-bioprinting explored above, it is necessary for us to resituate it as a concrete practice that is both enabled and fettered by the context in which it takes form. This is a correction to the utopic thought that might be invited by a particular reading of arguments above, which does not consider the extant milieus, extant pre-individual forces, extant sociolegalities that social processes cannot dis-embed themselves from and forget. In this way, the present, past and future are always inextricable, as social and material relations reach across these temporalities (Eisen et al. 2018).

Heeding this warning, we turn beyond the playful, artistic or aesthetic renderings which brim with explosive wonder and consider the legal regimes that intervene at multiple points in the process (in terms of development and engineering, use and printing and therapeutic applications) and constrain the sociolegalities 3D-bioprinting effects. This is a distinct sociotechnical imaginary, which overtakes the wonder-full imaginary sketched above. This can be conceptualised as a process of 'in-formation' (Simondon 2020), where certain pre-individual forces overwhelm the individuation process toward the reproduction of dominant, majoritarian tendencies. Here, using Canada as a case study, we look to: (1) the fact that 3D-bioprinted materials would presently be classified as autologous biologics subject to a legislative and regulative regime that prioritises therapeutic efficacy and safety;[3] and (2) the application of intellectual property to blueprints that

[3] See an explanation in the Government of Canada guidance document, *Health Canada Policy Position Paper – Autologous Cell Therapy Products,* available online: https://www.canada.ca/en/health-canada/services/drugs-health-products/biologics-radiopharmaceuticals-genetic-therapies/applications-submissions/guidance-documents/cell-therapy-policy.html.

delimit, quite narrowly, the production, movement and use of 3D-bioprinted tissues; among other laws, that in effect construct or reinforce the construction of 3D-bioprinted tissues as a drug, to be used by consumers to whom the technology is marketed as a therapy product.

In response to a question from the Senate of Canada, Canada's department responsible for federal health policy, Health Canada, identified that the '3D bioprinting process would be excluded from' regulations applicable to organs and tissues for transplantation, because the organic products contemplated by the proposed 3D bioprinting process would be 'more than minimally manipulated' (2017). Instead, the 3D-bioprinting process would be subject to either the *Food and Drugs Regulations* or the *Medical Devices Regulations*, or potentially both, each enacted under Canada's *Food and Drugs Act* (1985). The precise regulatory provisions applicable to 3D-bioprinting would be 'assessed [by Health Canada] on a case-by-case basis,' based on 'the principal mechanism of action by which the claimed effect or purpose of the product is achieved'. However, the organ and tissue products of 3D-bioprinting would likely be classified as autologous cell therapies: the bioprinted organ and tissue products would be derived from the corporeal material of the intended recipient of the therapy, with more-than-minimal manipulation to produce a therapeutic good.[4]

The *Health Canada Policy Position Paper — Autologous Cell Therapy Products* specifies that the *Food and Drugs Act* regulates the conditions of the production and use of autologous cell therapy products, so that if the therapy could be 'unsafe' or 'potentially harmful because it is ineffective,' 'anyone who processes it, or then distributes (administers) it, will have contravened the *Act*'. This includes 'the potential introduction of bacteria or viruses', 'between-patient cross

[4] Guidance from Canada's Minister of Health, *Health Canada Policy Position Paper – Autologous Cell Therapy Products*, specifies how 'emerging autologous cell therapy products' are to be regulated under the *Food and Drugs Act*. Its description of autologous biologics does not specifically name 3D bioprinting, but appears to cover the technology and its uses.

contamination', 'risks resulting from processing activities and exposure to processing reagents', and 'the stimulation of unwanted immune reactions, ectopic [or abnormally placed] tissue and/or tumour formation.' The *Food and Drugs Act* provides a scheme of inspection and licensing to address such risks, only authorising the marketing, sale and use of products that 'demonstrat[e] [they are] safe, of good quality and efficacious'; in other words, through demonstrating the absence of disruptive effects on public and individual health. The *Food and Drugs Act* would apply even though 3D-bioprinting ostensibly distributes the manufacturing process beyond centralised industrial sites into hospitals or clinic laboratories, and individualises resulting products for each specific patient, since 'the process is the product [from the perspective of regulation] and Health Canada has […] the ability to regulate highly variable products'. As a result, a delineation between lawful forms of organic matter intended for therapeutic use and that which is monstrous, hazardous excess or contaminant (Radomska 2018) perfuses the bioprinting process, in-forming and constraining how corporeal matter behaves.

Lastly, intellectual property and privacy rights (Kirillova et al. 2020; Vermeulen et al. 2017) would likely in-form the individuating process of bioprinted organs and tissues by limiting the movement of the device and blueprints, particularly by restricting unauthorised replication or access, affecting who may encounter the technology and the nature of that encounter. Intellectual property would likely affect the process with respect of the device itself and materials used to generate or maintain bioprinted organs and tissues (Ammar 2016), allowing the rights-holder to exclude others from producing, accessing or using necessary components. Privacy legislation would also likely apply to identifying personal health information in blueprints in the custody or control of health information custodians (e.g., hospitals, physicians, etc.), imposing obligations on custodians to act according to the consent of the individual from which the material is derived,

unless an exception (generally available in contexts of health system management or public health) allows the use or disclosure of the blueprint without consent (or the blueprints can be effectively anonymised in the context of the use and disclosure). Irrespective of the ontogenetic potential of 3D-bioprinting, these laws infuse constraints in the individuations of bioprinting organs and tissues. Such constraints would reinforce the autologous nature of the therapy by prioritising consent (whether that is the patient's consent or that of the property owner) and limiting the use of 3D-bioprinted products outside therapeutic spaces, anchoring 3D-bioprinting to medico-legal contexts where one's health is to be restored or augmented by professionally licensed care-providers.

This sketch indicates some laws that form part of the associative milieu of 3D bioprinters, constraining their corporeal products so that ontogenesis is not as radical as some might think (Li 2014; Li et al. 2020); instead, the process of producing body parts shores up and reifies conventional, liberal conceptions in law of the human body as individual, bounded and primarily contractual beings (Eisen et al. 2018; Mykitiuk 1994). In addition to the constraints noted above, these laws imbue aversion to the materiality of microorganisms or chimeric or hybrid tissues that cannot be known and subordinated or culled (Mehrabi 2020), or that resist conversion into 'spare parts' that restore prevailing medico-legal constructs of health (Kent et al. 2006; Van Wagner et al. 2008). Any broader relationalities inconsistent with this sociotechnical imaginary—whether with the human and more-than- or non-human—are expunged or dissimulated, ensuring liberal legal relations persist. This outcome would not be because law imposes categories without regard to 3D-bioprinting (Fisch 2018; contra Parry 2018), which places law outside the somatechnological practices of tissue engineering; rather, spatio-legal encodings are entwined in the process of bioprinting 'organising the movement and distribution of bodies and bodily parts

[as well as the pre-individual forces that subtend and exceed both] […] which collectively create the 'impression of the singleness of' a spatio-legal event' (Shaw 2021, p. 82), such as that of the organ, therapy, the healed body, etc. The enactment of these spatio-legal events potentiates in turn re-individuates the liberal legal subject amenable to ongoing projects focused on the regimentation, discipline and preservation of life, or biopolitics (De Lucia 2020; Thacker 1999). In this way, 3D-bioprinting does not merely rely on bioink; it relies on biopolitical ink saturated with legal meaning, which bleeds into the sociotechnical imaginaries 3D-bioprinting forms part of.

This is not to suggest there is no transformation in the resulting sociotechnical imaginary. Despite in-formation, pre-individual forces continue to move dynamically, leaking outside what is determined. Becoming may be dissimulated, less meaningful to human actors, particularly those buttressed by the state. It is possible other sociotechnical imaginaries may find a home in the sense of *mattering* to individuals and, in time, through the formation of jural communities, gain significance; in other words, the co-production between law and 3D-bioprinting may not be apparent until it makes legal difference (Pottage 2007). The work of Margrit Shildrick (2012; 2015; 2020) and colleagues (El-Sheikh 2020) with respect of the messy entanglements of post-mortem heart transplantation highlight this; law constrains the radical potential of transcorporeality, but that does not mean this process settles the individuation or the issue of regulation cleanly (Shaw 2021). There can still be an effect, even if that effect is one that is inflected through law's attempt to control and disappear it, that can be encountered, experienced and potentially in-form social practice. There is an 'antinomian' (Shaw 2021, p. 71) secretion—residual, minoritarian—that remains present, despite the pull of in-formation, that potentiates new legal meanings and relations.

Three-dimensional bioprinting may introduce ontogenetic difference, and potentiate a distinct sociotechnical imaginary, to the extent it, along with other regenerative procedures,

promises and realises a new temporality of the human: specifically, by repeatedly averting death. This may involve a hardening of the regulatory ideal of 'a purely technical model of the body in which the surgeon's task resembles that of an engineer' (Lafontaine 2009, p. 64), an ideal that is already continuous with organ and tissue transplantation (El-Sheikh 2020) and regenerative medicine generally (Lafontaine 2009), but not necessarily realised through the *augmentation* of material capacities. An engineering technicity designed around augmentation could introduce 'a new ontology of the body as an assortment of programm[able] machines' (Lafontaine 2009, p. 65), which would proliferate, rather than belie, the human as a species- (Thacker 1999) or even as a legal-subject.

With respect to the legal subject, we anticipate an engineering technicity would mediate the disembodiment of the human, bringing the human nearer to what, Elena Blanco and Anna Grear referred to as, 'the ultimate instantiation of liberal law's idealised person' (2019, p. 17): the *corporation* as a body capable of infinite division, reproduction and improvement (Blanco and Gear 2019). Disembodiment would arise from the hyper-objectification of the body and corporeal matters, allowing for its instrumentalisation, whilst entrenching the ideal of an individualised, bounded legal subject for whom instrumentation serves: a delineated subject-object relation is thereby preserved. A corporatised human would, like the corporation itself (Blanco and Grear 2019), seem to be endowed with flexibility and instrumentality whilst maintaining, if not enhancing, their individuality fundamental to contractual or property relations. This legal subject remains amenable to capital, merely prolonging the capacity to transact, consume and appropriate, rather than fracturing through embodiment. Transformation of the legal subject, dissolving its borders and allowing it to become something other than a pawn to capital, would necessitate an embodied ethic that expands response-ability to the more-than-human entanglements (Grear

2018), but this possibility seems overwhelmed by the associative milieu of capital that de-potentiate such transductions.

With respect to the species-subject, an engineering technicity is also likely to 'culminat[e] in a biopolitics focusing on the species-population' (Thacker 1999, p. 2), through the concurrent universalisation and individualisation of human health (health as a universal ideal, regulated and disciplined, albeit identified in the particular dispositions or performances of each subject), as well as the human body's construction as 'natural but transparently mediated' (Thacker 1999, p. 12). Both create value in 'the body as a potentially infinite natural resource' (Thacker 1999, p. 13) for consumption and as an object of governance. However, biopolitical projects focused on the species have never been experienced equally; the human as a species—as well as a legal-subject—is fraught by social formations of racialisation, colonisation and capital, which select some bodies as human and select out others as 'less-than-human' (Philo 2016, p. 257). Biopolitics have also combined a disciplinary mode of governance in which epistemes are internalised in bodily performance, and sovereign power in which that which cannot be subsumed or exploited under this norm of biological life are eradicated or otherwise banished (De Lucia 2020). Three-dimensional bioprinting would, under these in-formed conditions, seem to coincide with this tendency, in that, as Eugene Thacker argued, 'the biomedical body only returns to itself [in the imaginary] in a spiral which simultaneously moves upwards (an infinitely reproducible body) and downwards (an expendable body)' (1999, p. 5). The likely inequitable distribution of and access to 3D-bioprinting, which the technology itself does not prevent, portends this biopolitical outcome, by delimiting the space where its ontogenetic effects matter.

Conclusion

Returning to the frame of sociotechnical imaginaries (Jasanoff 2015a; 2015b), we considered the potential eruption of novel sociotechnical imaginaries having regard to law's contribution to, as well as its possible transformation by, the process of 3D-bioprinting including the bodily matter that is manufactured. We drew on Grosz (2012; 2017), Manning (2010; 2013) and Simondon (2020) to account for the ontogenetic mediations of technology on the production of the social world; namely, the process of individuation and pre-individual forces that comprise and yet exceed the procedure of bioprinting organs and tissues for therapeutic purposes. This included attending to how law and regulatory relations may in-form the process of individuating sociotechnical imaginaries through which the everyday encounters with the 3D-bioprinting process and its products are lived.

With respect of 3D-bioprinting in particular, such theorisations have aided us in describing how 3D-bioprinting, especially in contrast to bio-art, is relatively conservative in the legal meanings and orders it produces and reinforces. Most apparent forms of change engendered through the procedure will likely reinforce the development of a biopolitical regime, not its replacement. In particular, bioprinting may reinforce a biopolitical sociotechnical imaginary that reconstitutes experience and regulation of the body and health, not in democratizing or the radical directions as some have suggested, but rather toward uncertain horizons of a species- and legal-subject whose death is repeatedly averted. Uncertain in that retaining and enhancing the human as a species- and legal-subject, especially in this disembodied way (Grear 2018), risks re-entrenching a subject-object relation endemic to the Anthropocene (Pottage 2019), colonisation (Blanco and Grear 2019) and the jeopardy of marginalised lives (De Lucia 2020).

Speculative analysis was made possible through a material, spatial and embodied legal theory alive to the relation of bodies to law. Such a legal theory accounts for the processual qualities of sociolegal phenomena; it accounts for the micro practices of the body, of corporeal matter, of technology that continually subtend, exceed and transform individualised sociolegal forms. Doing so moves us beyond how sociotechnical imaginaries and law have been related by scholars in the past. Whilst Jasanoff and colleagues (Hurlbut et al. 2020; Jasanoff and Kim 2009) tend to relate sociotechnical imaginaries to law primarily through the nation-state (Dickel and Schrape 2017, p. 52), or other large structural edifices (Karpin and Mykitiuk 2021, p. 12), law's relations to such imaginaries are far more complex, plural and varied owing to the contingency and multiplicity of law (Karpin and Mykitiuk 2021). As demonstrated by 3D-bioprinting, this complexity becomes even messier through the body's recalcitrance—corporeal, material affections or agencies—which feminist jurisprudents and theorists have long argued is co-productive with law (Cheah and Grosz 1996; Eisenstein 1988; Mykitiuk 1994). Law and sociotechnical imaginaries are thereby more than immense structures, even if such structures can take form in the context of their co-production (Karpin and Mykitiuk 2021); both are thoroughly embodied in that law and imaginaries find expression through material forms (Pottage 2007) but also emerge from them (Philippopoulos-Mihalopoulos 2015; 2020). This is a move toward a fractal ontology of law that thickens the description of sociotechnical imaginaries that law forms part of, opening legal theory to the relations of law, technology and society otherwise obstructed by a pernicious anthropocentricism. Within this thickened description, a fractal ontology invigorates a non-anthropocentric critique of law and technology, and stages a jurisprudence of living and technological forms that moves creatively and wonder-fully in the fabrication of new sociotechnical imaginaries.

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