Momenta

On the cover

The graphic on the cover is a reaction–diffusion system from Thomas Diewald adapted from *openprocessing.org/sketch/496452.* Reaction–diffusion systems are mathematical models which correspond to several physical phenomena: the most common is the change in space and time of the concentration of one or more chemical substances: local chemical reactions in which the substances are transformed into each other, and diffusion which causes the substances to spread out over a surface in space.

Reaction–diffusion systems are naturally applied in chemistry. However, the system can also describe dynamical processes of non-chemical nature. Examples are found in biology, geology and physics (neutron diffusion theory) and ecology.

momenta (n. pl.) Latin

1. The indwelling forces that are the principle of change.

2. The circumstances that precipitate change.

The papers in this volume are momenta in the sense

[ii] that they are reactions to a set of circumstances (the ideas, the work of understanding, the opportunity to consider those ideas), and also in the sense

[i] that they make contribution to ongoing scholarly discussions and so inevitably change the course of those discussions.

Translated by Darcy Otto, Professor of Philosophy and Classics at Quest University Canada

ACKNOWLEDGEMENTS

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FOREWORDS

Dear readers,

We are thrilled to present this year's Momenta! Our fifth edition is filled with thoughtful commentary from a diverse assortment of disciplines that showcase the creativity, academic rigour, and interdisciplinarity of Quest students. Momenta continues to thrive in our community as an excellent academic extracurricular; a space where students join together to inspire excellent writing by reading, reviewing, reflecting and revising. This year has been no exception -- Momenta saw more student peer reviewers, paper submissions, and published papers than ever before!

Our fifth edition has grown even longer than previous years, with the addition of Quest's Scholarship Symposium proceedings. In November, Quest students took the stage to present their research to the community with 15-minute presentations. The Symposium showcased innovative, thoughtful, and engaging projects. We publish these proceedings to commemorate and continue discussions about these students' work, and we hope you enjoy this snapshot of their research.

As with all past publications, this edition has truly been a community effort. These pages represent an enormous amount of work from student authors and peer reviewers to faculty supports. We have come together out of a shared value for collaboration and curiosity, and we're grateful to each and every person who has participated in Momenta. Like most initiatives at Quest, this publication was conceived, created, and continued by the efforts of volunteers who enrich our community--thank you! This year, we are especially grateful to the Rhetoric Across the Curriculum Committee and the Research, Scholarship, and Creative Works Committee, for without their funding and support Momenta would not be possible.

Finally, we'd like to thank you, the reader. Thank you for taking the time to read these words. It is an absolute pleasure to share Momenta with you; we hope you find the writings as inspiring, thought-provoking, and interesting as we have.

Yours,

Lauren Bauman
Michael Geuenich
Sarah Chudleigh
Emily Glasberg

Welcome to the latest edition of Momenta, Quest's peer-reviewed journal, produced by students for the world. The writing here embodies what I love about Quest – the inquisitive energy. It is colourful, inspiring and a delight to experience.

I walked through the words and found them taking me places. I found myself pondering who and what Botticelli was conveying in the Idealized Portrait of a Lady in the 1840s. I wondered about the use of the structure and rhetoric of debt as it pertains to how we relate and interact with our Indigenous sisters and brothers. Debtors and creditors, the oppressed and the oppressor. Be aware, and become "fully human." I saw myself through the lens of the ever-proliferating surveillance devices in society and got insights into how this can shape the communities, seen. My hope that we correct our wasteful ways was uplifted by learning about bacteria that can degrade polyethylene. Wow — a bug for the times! The words walked through me and places found me.

Dive in and lose yourself. Enjoy it to the fullest. I did.

George

George Iwama
President & Vice-Chancellor
Quest University Canada
27th March 2019

Interrogating Canadian Reconciliation Politics of Debt

Anna Carlson-Ziegler

Dominant conceptions of social debt hold significant power insofar as their ability to reveal state intentions regarding reconciliation and reparations. In the Canadian context, the relationship between the state and indigenous groups is often discussed in terms of debt and debt recognition, particularly in the Truth and Reconciliation Commission where the state is positioned as the debtor and indigenous groups as the collective creditor. I problematize the state's use of debt rhetoric through an exploration of three primary tensions between Canadian and indigenous cultural frameworks: accumulation versus reciprocity, individualism versus collectivism, and time versus place. Drawing on Glen Sean Coulthard's rejection of the state's politics of recognition and Taiaiake Alfred's proposal of restitution, I argue that the rhetoric of debt invoked by the state reproduces existing colonial relations of power.

Although financial understandings of debt dominate popular discourse, debt is a social relationship at its core. Debt is necessarily borne of a power differential and, thus, reflects the power dynamics of a relationship (1). As a result, morality is inherent in debt and acts as an underlying mechanism by which the global debt-based economy functions (2). On the surface, debts are repaid in order to avoid punishments like credit card fees; the deeper reason debts are serviced is to avoid social punishment via internal and external moral judgement. Morality is enacted through the construction of subjectivities for the debtor and creditor; debt prescribes the debtor a character of moralized guilt (3).

Debt transcends economics and functions as a broader cultural framework in the Western world. In the last four decades, neoliberalism has emerged as a globally dominant economic doctrine advocating free markets, free trade, and private property rights (1, 4). The neoliberal capitalist context encourages the abstraction of social relationships into financial ones (1). Powerful governments and actors rarely speak about abstract social indebtedness between groups of people.

Canada's ongoing settler colonialism presents a unique opportunity to investigate the implications of social debt-centered rhetoric on a national scale. Settler colonialism refers to a system of power which enforces repression of indigenous peoples[1] via dispossession of land, resources, and cultural genocide (5, 6). The state's core pursuit is of land; "territoriality is settler colonialism's specific, irreducible element." (7). After declaring nationhood in 1867, the British Crown collaborated with First Nations to create treaties in the spirit of sovereignty and respect for First Nations' innate right to land. In a perversion of the treaties, the state instead embarked on an extended process of settler colonialism, including the particularly egregious practice of residential schools. From 1831 to 1996, the government forced 150,000 indigenous children to attend religious boarding schools with the explicit purpose of cultural assimilation. A majority of children experienced emotional, physical, and sexual abuse. 6,000 children died in these schools. (8, 6). These experiences continue to cause trauma and dysfunction in indigenous communities (9). As a result of a variety of oppressive socioeconomic policies, indigenous peoples today suffer outstanding land claims, a severe lack of resources and opportunities, and unequal funding for basic educational and housing needs (10; 6).

In the early 2000s, the Canadian government created a Truth and Reconciliation Commission (TRC), headed by two prominent indigenous leaders and a nationally renowned Canadian journalist. However, the government and the TRC present disparate visions of reconciliation. I argue that the discrepancy between the government's debt-centered rhetoric and the TRC's action-centered recommendations illuminate the government's intention to reproduce colonial relations of power between state and indigenous groups, rather than take TRC-recommended action to change the foundation of the relationship. In positioning reconciliation as repayment of debt, Canada seeks to ease its own guilt and satiate the general public with a message that colonialism is in the past and has been resolved. Under the guise of this repayment, Canada enables itself to continue the colonial project of dispossession and suppression of indigenous peoples.

The Canadian government and the Canadian public largely conceptualize the TRC's final report as a form of atonement via the acknowledgement of debt. The TRC was commissioned with the primary purpose of recording the history of resi-

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1. *Indigenous peoples* refers to First Nations, Metis, Inuit, and all descendants of people who lived in the territory now known as Canada prior to the arrival of European settlers. This is distinct from government definitions which legally recognize some as First Nation or Indian.

dential schools (9). I posit that the government's intended use of the TRC's final report acknowledges the country's debt to indigenous populations and by publishing this report, the government considers its debt repaid. Recognition is synonymous with repayment.

However, the TRC itself contradicts this view and offers a more holistic, action-oriented vision of a reconciliatory future. The TRC's final report defines reconciliation as a never-ending process intended to promote awareness, acknowledge the violence committed, and make amends which include the reconsideration of "virtually all aspects of Canadian society." (6). This vision expands far beyond the simple filing of a document and a national apology. Although the government monetarily and rhetorically supported the TRC throughout its process, their actions towards reconciliation are remarkably different than the actions recommended by the TRC's final report. Therefore, the government's debt framework is insufficient and incompatible with indigenous understandings of true reconciliation.

The government's debt-centered rhetoric and the Commission's action-centered rhetoric reveal unspoken understandings of the relationship between the Canadian debtor and the indigenous creditor. Social debt takes on significant new complexities in the context of a debtor with enormous social power. Canada asserted its right to create a debt without the consent of the creditor. Since the beginning of Canada's settler colonial project, the federal and state governments have experienced minimal legal, economic, or social threat from indigenous peoples. As a result, individual Canadians typically either contest the existence of their debt or enjoy total ignorance of their debt (11; 6). Marxist philosopher Antonio Gramsci's concept of hegemony suggests that one's social class limits the degree to which one can recognize systems of class and inequality (12). For white Canadians, this is compounded by an intolerance for racially charged conversations and high level of fragility (13). Indeed, it is quite difficult for Canadians to recognize their complicity in and continual benefit from an ongoing colonial project (6). As black American scholar Ta-Nehisi Coates describes the American context, in explicitly debt-oriented terms:

"there is a strange and powerful belief that if you stab a black person 10 times, the bleeding stops and the healing begins the moment the assailant drops the knife. We believe white dominance to be a fact of the inert past, a delinquent debt that can be made to disappear if only we don't look." (14)

As such, decolonial ideas often encounter willful ignorance or defensive confusion (13). Though the government appears to have taken a less defensive approach than its citizens, their approach to the TRC is hardly more revolutionary than outright ignorance or denial of colonialism.

The conflict between the government's debt framework and the TRC's recommendations reveals that the debt framework is relatively useless in the context of indigenous systems of thought. The Canadian state and indigenous groups do not operate on the same understanding of social debt because many aspects of the two cultures are fundamentally opposed. Out of many relevant tensions, I will highlight three: profit-oriented debt versus reciprocity, neoliberal individualism versus collectivism, and an emphasis on temporality versus an emphasis on place. A just path forward is necessarily dictated via the terms of indigenous groups, who aim to "know the ancient ways and apply them to present endeavors" (15). In failing to reflect traditional and contemporary indigenous perspectives, the dominant debt rhetoric of reconciliation reproduces the same colonial power relations in new iterations.

The Western debt economy is characterized by a monetary value-oriented understanding of debt which abstracts its social relation and positions it as a mechanism for profit (1). Since its early stages, capitalism has facilitated accumulation by dispossession with land expropriation and violence among the primary methods (11; 4; 12). Today, dispossession is characterized by financialization, the global expansion of the debt economy, and increased exploitation of people and resources (16). In stark contrast, many indigenous groups in Canada have operated since time immemorial on an economy supported by a culture of interconnectivity and reciprocity (17). In opposition to profit-oriented debt, indigenous economies prioritize the sustainability of relationships and material life and resources (18; 17). These systems operate on the logic of the gift, by which giving is considered essential to the active relationship between humans and the natural world. The logic of the gift is based on principles of sustaining balance within these relationships, which reflects a view of the world as a web of reciprocal relationships. (17). Whereas Western culture typically idolizes individuals' accumulated wealth, some indigenous cultures define social status as one's ability to give and facilitate giving (19).

In a Western context, time is the determinant of everything and the central organizing tenet of society (11). Prominent Western notions of debt and delinquency rest on temporality: an urgent need for money, projecting into the future, and securing outcomes. When relationship is conceptualized in terms of exchange and debt, the repayment of a debt typically signifies the end of a relationship (1). In present day Canada, a debt framework allows the state to situate colonialism in the past and leave it behind once repayment is achieved. On the contrary, in indigenous frameworks, place is the central organizing tenet of society. Place is the source of all epistemologies and identity, place facilitates collective wisdom, and place guides cultural values (11; 20; 15; 21). Land acts as the primary motivator of indigenous decolonial and anti-capitalist movements and scholarship (11). Indigenous movement victories depend on local culture and place-based knowledge (21; 20). As a result, many Western critiques of neoliberal capitalism discuss the system's theft of time, whereas indigenous scholars' critiques center on the theft of land (11). In a Western framework, debts can be resolved and left in the past as time moves on; in an indigenous framework, time is somewhat irrelevant and return of lands is an essential component of reconciliation.

Since the 1970s, neoliberalism has facilitated the rise of a profoundly individualistic Western culture. As an ideology and a political project, neoliberalism insists on liberating individual entrepreneurial freedoms to achieve well-being (4). This view obscures societal structures of power and results in a culture which considers each person to be responsible for their own life out-

comes (22). Indigenous cultures in the territory now known as Canada are traditionally characterized by collectivism, an opposite worldview to general Western understanding. As a political economic theory, collectivism requires a conception of political freedom that balances personal autonomy with accountability to family, community, and wider group (18; 11). The resulting systems are typically non-hierarchical (11). In indigenous groups in Canada, this cultural foundation results in practices like consensus-based decision making and restorative rather than penal justice systems (23).

Ultimately, a Western debt economy requires an exploitative, profit-oriented view of debt and a culture of individualism. In applying a debt framework to the politics of reconciliation, Canada suppresses an indigenous vision of reconciliation.

Furthermore, indigenous scholar Glen Sean Coulthard argues that the state is invested in a politics of non-reciprocal recognition. In the last thirty years, indigenous self-determination efforts have centered on a pursuit of recognition of state treaty obligations, right to self-government, and so on in order to reconcile their existence with settler-state sovereignty. Coulthard applies a problematized version of Hegel and Fanon's dialectics of recognition. Ultimately, he posits that the reproduction of dominant structures requires that indigenous peoples accept the asymmetrical form of recognition granted to them by the state (24). As stated previously, the Truth and Reconciliation Commission was intended to resolve past wrongdoing without creating a substantial change in relationship or power differential. The government considers recognition to be sufficient debt repayment and as such, is unlikely to make changes proposed by the TRC's final report. Applying Coulthard's analysis, I argue that in promoting recognition of colonialism as repayment for colonialism, the state requires indigenous groups to implicitly accept this recognition as sufficient.

Kahnawake Mohawk philosopher Taiaiake Alfred concurs that reconciliation is a "pacifying discourse" which serves to absolve the state of guilt and reproduce existing colonial power dynamics (18). In a near-explicit reference to debt frameworks, he insists that state-sanctioned reconciliation is built on a concept of guilt which is "foreign" to indigenous cultures (18). Truly decolonial political struggle must directly confront social and economic practices, such as debt frameworks, that perpetuate colonialism (25). As cultural theorist Franz Fanon said, minoritized communities must…focus on their own values as method and style." (15, 26). As an alternative, radical indigenous scholars present restitution: the return of lands and transfers of government funds to indigenous peoples to the point that they can be self-sufficient. Restitution is a solution built on indigenous frameworks of acknowledgement, acceptance, and "purification" such that a new nation-to-nation socio-political relationship becomes possible (18). Ultimately, Alfred argues towards additional radical change towards which restitution is only the first step. The answer to past and current pain is an ongoing rebuilding and restructuring of relationship. In this understanding, debt is never repaid or put in the past. Arising out of an indigenous cultural framework, restitution abandons the constraints of Western debt rhetoric to suggest a transformation which facilitates an indigenous definition of justice.

The Canadian government marked the advent of the Truth and Reconciliation Commission with the aim to acknowledge what they viewed as a debt to indigenous peoples: hundreds of years of cultural and physical violence. Though the TRC's final report asserted a need to change the very foundation of the state's relationship to indigenous peoples, the government intends and has always intended for the acknowledgement itself to serve as a sufficient repayment of debt. This discrepancy highlights the opposition of Canadian and indigenous frameworks. Debt is an inadequate framework and rhetoric because of its exploitative, temporal, and individualistic nature. The Canadian state's politics of reconciliation, underpinned by a Western conceptualization of social debt, serve to reproduce the same power dynamics that enabled the last 250-some years of settler colonialism. As Alfred concludes, "the crime of colonialism is present today, as are its perpetrators," (18) and reconciliation must be deconstructed in order to create the foundations for justice.

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Is Interpretation Oppressive?

Daniel Lee

In his book, *Pedagogy of the Oppressed*, Paulo Freire argues that oppression as a whole must be overcome in order for both oppressor and oppressed to become "fully human" (1, p.55). Freire asserts that this overthrow can only be achieved by a pedagogy in which knowledge is co-created by means of dialogue between equally valid voices. This requires not only that the oppressed become *critically aware* of the oppression in which they are embedded, but also that they *take responsibility* for their own being in light of the awareness, because, Freire argues, the freedom to determine one's being is an essential part of being human. This essay is concerned with this concept of freedom and its implications for Freire's project which is the permanent dismantling of oppression. While Freire's concern is at societal levels of oppression in particular, his definition of oppression is general enough that its relevance to the structure of human experience from the perspective of hermeneutic phenomenology is evident. Although I do not dispute Freire's claim that oppression at societal levels ought to be overcome, I suggest that, when we take a phenomenological perspective on human experience, his definition of oppression does not allow for the possibility of altogether overcoming oppression, which is the purpose for which his pedagogy was conceived. But because Freire's goal of the liberation of oppressed peoples has unquestionable value, the following argument is a constructive critique and not a rejection of his project.

Freire defines oppression as any situation in which someone hinders another's "pursuit of self-affirmation as a responsible person," adding that "such a situation in itself constitutes violence…, because it interferes with the individual's ontological and historical vocation to be more fully human" (1, p.55). For Freire, being "more fully human" means being free to determine one's own behavior. Thus, an individual is *oppressed* when her behavior is *prescribed*, where a prescription of behavior is an "imposition of one individual's choice upon another, transforming the consciousness of the person prescribed to into one that conforms with the prescriber's consciousness" (1, p.47). It is not difficult to see how this definition accords with familiar examples of oppression. For example, the assimilationist project of residential schools was, on Freire's definition, an example of oppression, since the intention of assimilation was to impose colonial supremacy and to prescribe behavior to indigenous peoples for the purpose of transforming their consciousness to conform to colonial interests. Such instances of oppression in which a group of humans is oppressed by another, where a "group" might be identified by any number of distinctions (e.g., socioeconomic class, race, gender, etc.), is the kind of oppression with which Freire is primarily concerned. However, without dismissing the particularly unjust nature of these kinds of oppression, I argue that, from the perspective of hermeneutic phenomenology, they have their foundation at the more primordial level of human experience. But if primordial oppression cannot be eliminated from human experience, then Freire's project requires modification, because he does not make a categorical distinction between higher and primordial levels of oppression, but argues for the liberation of peoples from oppression *in general*.

I begin by asking: What is the relevant meaning of 'freedom' for Freire? We understand that it is a necessary condition for humanity which is taken away by oppression, which is why oppression *dehumanizes*, and that it is liberation from *prescribed* behavior, which is behavior that one did not choose but which was *imposed*. So an unoppressed individual is one that is liberated from prescribed behaviors. This links closely to Freire's idea that *authentic* actions are liberated and 'free' choices, whereas *inauthentic* actions are prescribed choices. In other words, when people are being *authentic*, they are being "wholly themselves," and they are living by choices instead of "following prescriptions" (1, p.48). To return to our example, an indigenous student in the context of residential school education clearly ought to be liberated from the imposition of the colonial pedagogy upon her experience. However, colonial impositions are not the only limitations on her vocation of authentically determining her own being. Her parents' choices for her are oppressive impositions according to Freire's definition because they are prescribed behaviors and not *chosen authentically* by her as an individual. The indigenous student's own native culture is oppressive because it involves imposition of prescribed behaviors; if she were *truly* autonomous, she might choose *not* to think or behave according to the norms of her culture.

From the perspective of hermeneutic phenomenology, thinking, or, more generally, *experiencing* the world is structured by a continuous and inescapable process of *interpreting* the world. Experiencing the world in accordance with particular norms (cultural or otherwise) is to interpret the world in particular ways

signified by the norms in question. According to the phenomenologist John Russon, to understand that human experience is fundamentally interpretive is to understand that "whatever perception we have of the world is shaped by our efforts to organize and integrate all of the dimensions of our experience into a coherent whole" (2, p.10). In general, the process of *interpretation* is contrasted with what might be thought of as disinterested perception of "raw data" because when we *interpret*, we are always seeing the "raw data" as something (2, p.15). In other words, to interpret something is to *make sense of it*, or to see it as being *significant* in one way or another. Interpretation in this sense encompasses a broader scope than what we typically might think of when, for example, we think of *textual* interpretation. The hermeneutic phenomenologist's understanding of interpretation *includes* textual interpretation because when we interpret a text we are trying to see it as meaning something which is not spelled-out by the text. But simply *reading* is also interpretation, because when I read, I need to see the script on the page as meaning something, that is, as being more than random black marks on a page. But it applies to even less familiar examples: If I experience Vancouver as being 'home,' this is also an interpretation because in order to experience 'homeness,' I need not merely to perceive the 'raw data' of my surroundings, but to see them as *familiar* and *comforting*. In what follows, I try to show that *interpretation*, which, in the hermeneutic phenomenologist's perspective, is the foundational and inescapable structure of human experience, is the primordial basis of the oppressor-oppressed dichotomy.

As Russon argues, the interpretive nature of human experience implies that experience is fundamentally structured by impositions on one's choice to the extent that 'autonomy,' in the sense of choice without imposition, is a fantasy (2, p.90). Because a given object or world of objects affords different interpretations to different people depending on their particular historical orientations toward them, any interpretation excludes others. For example, while I might experience Vancouver as being 'home,' a different person might experience Vancouver as "threatening and oppressive" (2, p.10). In general, "[t]he homey or threatening character of this site is a reflection of our developed identities, and not of an inherent feature of the independent objects that confront us" (2, pp.10-11). But this fact about the possibility of interpreting a given place in any number of ways depending on one's historical orientations toward it is equally true of any of the potential objects of experience. As Ian Bogost observes, objects "recede interminably into themselves," that is, into the infinities of their possibilities for being, and human interpretations constitute only "one among many ways that objects might relate" (3, p.9). In other words, by interpreting objects, we oppressively impose our interpretations upon them, because objects are not free to be 'fully themselves' if what they are always eludes encapsulation by any particular interpretation. This 'interpretive oppression' is more primordial than Freire's intersubjective oppression which prevents both oppressed and oppressor from becoming 'fully human,' because the latter is a kind of the former. Russon's own phenomenology points to this connection because our experience of others in the intersubjective realm is a part (albeit, the most important part) of our experience as embodied contact in the world (2, p.51). Although, for each of us individually, other people may be special objects of experience, nevertheless, as objects of experience, our relationships with them are figured by the fundamental structure of interpretation in general, which, I am arguing, falls under Freire's definition of oppression.

But Freire writes that intersubjective oppression not only prevents the realization of the humanity of the oppressed but also that of the oppressor, because the oppressive situation is such that "both are submerged in this situation, and both bear the marks of oppression" (1, p.58). In an analogous way, interpretation prevents not only the realization of the being of the object interpreted but also that of the interpreter. This is because we are habituated to particular interpretations as strategies for dealing intelligently with the world. Habituation is what allows us to "establish new dimensions of familiarity within…formerly strange arenas of experience" (2, p.29). For example, speaking a foreign language is not something that one can do effectively the first time one attempts it. In order to be able to understand and speak a new language, one must repetitively strive to learn, to habituate oneself to the new language. Once it is learned however, one is not free to 'unhear' the meaning of the new language, and this is precisely because one has become habituated to it. Habituation to particular interpretations means that we cannot freely choose which interpretations of objects to hold any more than we can freely choose not to understand the words of a language we understand as being words of a particular language. Annie Dillard notes the same fact when she writes that, in a sense, we are condemned to meaning (4, p.31). For example, she observes that even depth perception is an interpretation of experience that isn't simply 'raw data' given directly from some objective world 'out there' (4, p.27). For Russon, the "vision of human existence according to which the power of choice is simply given to us as already fully within our control," and habits of interpretation and behavior are merely external impositions upon this free choice that we can simply shake off in order to realize our 'authentic selves,' is an illusion perpetuated by an inaccurate description of human experience (2, p.90).

The illusion of the 'authentic self' has been criticized by others as well. Feldman echoes Russon's sentiments in his objections to the concept of authenticity, arguing that "The Ideal of Authenticity sets up false dichotomies between self and other" (5, p.18). In other words, the concept of a self 'behind' the impositions of others (e.g., the impositions of society) is a false representation of the Self that nevertheless retains its appeal in its call for individuals to "be true to oneself," as if there were a 'true' oneself somehow made 'false' or inauthentic by the impositions of others (5, p.2). The reality is that the 'true' self is the Self shaped by its interactions in the world. Indeed, Freire seems unwilling to go as far as the stoicisim of the authentic individual characteristic of objectivist world-views, because he recognizes that oppression "engenders an entire way of life and behavior for those caught up in it—oppressors and oppressed alike," such that there are serious existential hindrances originating in either direction to the elimination of oppression (1, p.58). But because he fails to distinguish categorically between unquestionably oppressive impositions on individual choice (e.g., residential school education) from the kinds of impositions on individual choice which are inextricable from the interpretive structure of human experience, the possi-

bility remains that Freire's goal of overcoming oppression in general is unattainable. In other words, if impositions on one's choice are oppressive, either we cannot overcome oppression, or we can only (and need only) overcome the unjust kinds of imposition. In the latter case, we ought to modify Freire's definition of 'oppression' along the lines of this unjust kind of imposition.

But in order to modify the definition of 'oppression' to be in accordance with the unjust kind of imposition, we must be able to identify the unjust kind of imposition distinctly from those which fundamentally structure human experience. This might be seen as a requirement for a definition of justice, but such a definition is almost certain to be limited. But perhaps without an objective definition, we can still recognize examples of justice versus injustice when we see them. This view has much to recommend it, since even people who disagree about the precise definition of justice can still agree that residential school education was an unjust imposition. The danger of this point of view, however, is that there is a tendency to rely on one's instincts, which in too many cases involves retreating into one's existing habits of interpretation. This is where Freire's call to critical consciousness in his liberation pedagogy provides us with an insightful alternative. Instead of relying either on a definition which will necessarily be limited, or on one's instincts (which, in many cases, are habits of interpretation which may be unjust ways of dealing with some situations), we can rely on critical awareness to reveal the unjust structures of interpretation in which we are embedded. Critical awareness, for Freire, is the process by which "people discover each other to be 'in a situation'" (1, p.109). For people to become critically aware of their situation is to "emerge from their submersion," that is, to emerge from unreflective submersion in particular situations to a state of reflective awareness about the limits and characteristics of those situations (1, p.109). The problem with this approach, however, is that habits of interpretation, although they oppress both the interpreter and object interpreted, are useful. As Russon observes, habits of interpretation are formed intelligently on the basis of particular contexts, and as such, are useful in those particular contexts (2, p.87). So perhaps it is not only the case that we cannot overcome oppression in the sense of impositions upon one's 'free choice,' but also that we ought not to overcome all kinds of imposition. Habituation is what makes possible the development of "new dimensions of familiarity within these formerly strange arenas of experience," such that formerly difficult practices "come to operate for us without explicit reflection or self-conscious control" (2, p.29). A particularly illuminating example of this is the hammer in Heidegger's tool-analysis which, because of its being ready-to-hand, recedes from us in its infinite being and exists only as something which does something for us. Indeed, our familiar interaction with it oppresses its being and privileges our relationship to it, but we typically consider this to be a boon and not a hindrance, because the inconspicuousness made possible by habituation is what allows us to use the hammer effectively.

Based on what has been said thus far, the question indeed seems to be: Which kinds of interpretive impositions are oppressive and which are not? However, perhaps the question ought to be: How do we limit the unjust nature of our interpretive contact with other people? As I have argued, we can no more eliminate oppression as defined by Freire than we can cease to interpret and become habituated to interpretations. This point is well put by Levinas, who suggests that, for each of us, simply the fact of our existence, our very "place in the sun" is the "usurpation of spaces belonging to the other whom [we] have already oppressed" (6, p.82; emphasis added). In this light, what hope can there be for eliminating oppression? Perhaps none, but this is the extent of my criticism of Freire—we must surely go further. The existence of unjust oppressive situations means that we cannot stop searching for answers, and we ought to take what insights can be gained from Freire's analysis of the structure of oppression. In any case, the arguments here and the reflections of Russon and Levinas suggest that we need to go further than Freire's somewhat naïve assertion that the right kind of pedagogy can overcome oppression altogether.

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They're Always Watching:
A Geography of Mass Surveillance and Race in Urban Spaces

Oliver Rothenberg

Introduction

How do surveillance technologies impact those who are disproportionately targeted by the criminal justice system? Does an increase in safety and security for some come at the cost of persecution for others? It is apt to examine the potential of adverse effects for those who already bear the burden of an unjust system of discipline. Surveillance primarily functions as a visual means of control and, thus, "is fully schematized by racism." Observed bodies are often classified as criminals, and acted upon as such, due to a set of "racial optics that target the body as a contiguous surface of legible information about capacity and pathology" (1). It is feasible, then, that the mass installation of surveillance will lead to the creation of spaces that exclude racialized bodies via threats to their psychological well-being. This essay will approach this issue in three parts: first, it reframes and critiques Michel Foucault's Panopticism; second, it examines the ways in which urban spaces are (re)constructed due to widespread video surveillance, with a specific focus on Camden, New Jersey; and third, it turns to the possible implications of the increasing digitization of surveillance systems. I argue that the disproportionate allocation of psychological impact in the utilization of mass surveillance apparatuses is an act of racial domination and transforms urban areas into spaces that reify subjugation.

Part I: Race in the Panopticon

In his book, *Discipline and Punish*, Michel Foucault describes Jeremy Bentham's Panopticon as a prison in which the layout — prison cells in a circular formation around a central watchtower — "arranges spatial unities that make it possible to see constantly and to recognize immediately" (2). The great power of the Panopticon in ordering the individuals it confines is that it acts upon psyches to enforce a system of self-discipline. It allows not for superior direct surveillance, but for a "'power of mind over mind'" (2). The warden no longer needs to orchestrate power because the prisoners become the "principle[s] of [their] own subjection" (2). The system relies upon the perceptive capabilities of those within it; only when a prisoner is made aware of their position within the machine are they subject to it. If an individual woke up in a cell with no knowledge of how they got there and no understanding of the looming tower in the middle, the Panopticon would hold no power over that individual. With the necessary knowledge, however, there could be no one in the center tower and the system would still function. Thus, the system requires that individuals have some knowledge of their position. The utilization of a panoptic mechanism becomes further questionable when physical positional knowledge is compounded by an individual's knowledge of their status within societal power dynamics. The technology can be problematic as it allows for racialized people — those who have been marked as non-white within a system that privileges whiteness — to be subjected to panoptic forces more intensely than others.

The aim of the Panopticon "is to strengthen the social forces - to increase production, to develop the economy, spread education, raise the level of public morality; to increase and multiply[,]" but this appears to come at the cost of just distribution of these benefits (2). If the power dynamic within society discriminates against individuals who possess certain traits, e.g. skin colour, the Panopticon works more intensely upon certain bodies than others. As long as an individual is aware of their standing within a power structure when they come to exist within the Panopticon, the Panopticon will disproportionately regulate. In a society such as ours, where these biases are often very clear, those traditionally subject to such biases will be hyper-aware of their heightened subjugation. Within a state apparatus that unfairly targets non-white bodies for persecution, the threat of surveillance becomes far more severe for non-white bodies; the same can certainly be said for other inequitable persecutions as well. As such, the perceived risk of straying from the demands of an authority within the Panopticon is explicitly linked to specific identifying traits.

Foucault himself notes that new criminal justice technologies — among which surveillance apparatuses would undoubtedly be included — tend to categorize individuals who "resemble [their] crime before [they have] committed it" (1). This makes the omission of race in his conceptualization of the panoptic system of surveillance all the more confounding. Only in a thought experiment where race, class, gender, etc. are not taken into account can the Panopticon function fairly. The ways in which such a system unfolds in our material reality, however,

do not meet such aspirational heights. An analysis of surveillance within an urban area in North America allows us to apply this criticism to a contemporary panoptic model. Before fully exploring the analogy between urban surveillance and the Panopticon, however, it is necessary to clarify the differences and similarities between the two.

On the surface, the difference between surveillance within a city and a prison as models of control seems clear. Critical analysis, however, shows that many of these differences apply only to specific, privileged bodies. First, the city is often posed as a site in which individuals are allowed to move their bodies freely; apparently, there exist few to no physical barriers which prevent access to public space. Though few bodies in a city "suffer continuous confinement," I am inclined to highlight the disparities in freedom of movement between certain bodies (3). Whereas white males have relatively unrestricted access to public spaces, racialized bodies are often stripped of such freedom. Practices such as the legal codification of a colonial "spatial confinement" of aboriginal women to reserves and the disproportionate criminalization of, and state violence against, black bodies exemplify this disparity (4). Second, though "a city is a space of endless encounters" and thus seemingly defies the component of isolation within the Panopticon, social isolation can occur without such literal physical barriers (5). The ability to tap into social groups is complicated by a state that targets and disrupts gatherings of certain bodies while permitting the same for others. So, despite diverging with respect to certain bodies, surveillance within a city is still analogous to the Panopticon because it is "visible and unverifiable"; as one walks through the surveilled city one is constantly aware of the potential of observation, even though it is impossible for an administrative body to truly observe everything at once (2). With the clarification of the city/Panopticon analogy, the case study of video surveillance in Camden, New Jersey shines a light on the tangible impacts of panoptic mass surveillance apparatuses on racialized bodies.

Part II: Observe and Protect

Camden, New Jersey serves as an excellent example of the ways in which modern panoptic surveillance shapes urban space and encourages associations of blackness and criminality. As of 2013, there were 121 police surveillance cameras within Camden[1]. These cameras were set up as part of a campaign to "[redefine] the relationship between the police department and its people," in a city with the highest murder rate in the U.S. (6). On the surface, these systems seem effective: since 2014, the amount of murders has dropped by almost 70%, the amount robberies by 33%, and burglaries by 27% (7). Former President Barack Obama even went so far as to describe Camden as a "symbol of promise for the nation" (8). Such a measure of success does not, however, fully encapsulate the complexities of societal systems of control. It is essential to also examine psychosocial impacts that cannot be so neatly reduced to data points. Camden has been, at the very least, physically altered by the installation of surveillance devices.

Does the tangible good of crime reduction outweigh the potential negative impacts upon marginalized bodies within the city? This section will examine Camden's surveillance system to illustrate the ways in which it constitutes a project of racial domination.

It is useful to open with the technology within Camden's surveillance project that most directly resembles Bentham's Panopticon: a mobile observation platform called "Sky Patrol." Sky Patrol is a 9.2-meter tall crane equipped with zoomable cameras that, according to the manufacturers of the device, enables one officer to single-handedly observe a 1.2 km radius (9). It lessens the need for multiple patrols of a given area and can be used to surveil areas otherwise out of the public view. The utilization of a single observer and the unverifiability of their gaze imposes a panopticism upon bodies within the radius of observation. The officer still cannot observe the entire area at once, but, if the presence of the Sky Patrol is known, all those within its range will be subject to the psychological pressures of surveillance. Beyond the issues of race discussed in the previous section, this technology is problematized by its collapse of the boundaries between public and private space. The Sky Patrol system has been criticized due to the potential for officers to look into private residences typically outside of their view during patrols. A spokesman for the county was quick to dismiss these invasions of privacy by saying residents "can close [their] shades," but that response completely dances around the problem (9). People living in Camden are apparently not entitled to a spatial removal from the gaze of the state. The predominantly black bodies within this urban space remain subjects to a greater degree than those within spaces where these surveillance measures are absent. People within this racialized space are expected to be constantly responsible for the visibility of their body; a process of self-surveillance and regulation has leaked into spaces meant to afford privacy and comfort. Such issues of public surveillance spilling over into the privacy of the home also highlight the lack of consent from surveilled bodies within this system.

The lack of consent within the Camden surveillance project is affirmed in a PBS special on Camden in which one of the men interviewed says: "If the police department came to me and said, you're going to have to give up all your privacy, but we're going to reduce crime, then make you a little bit safer, I would probably say no. Nobody came to me and asked me that" (7). The lack of consent from the citizens being surveilled further poses the installation of this surveillance system as not just a problematic use of technology, but a targeted act of domination. There is no discourse between the county administrators that surveil and the citizens who are surveilled. This, in turn, enforces a paternalistic relationship to a greater degree than that typically found in state/subject relationship. The problematic nature of this paternalism is further amplified by the positionality of the bodies that occupy the administrative space, and their failure to represent those within the city of Camden.

In Camden, all law enforcement is administered by the county police rather than a municipal force. The city of Cam-

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1. With Camden's total land area of 23.106 km² this amounts to roughly 5 cameras per square kilometer.

den has a largely African-American population[2], while Camden County has a majority white population[3]. This spatial power transfer reinforces a dynamic in which white bodies maintain control over black bodies; the observers are situated in a removed white space that absolves them of the negative criminality imposed upon the black space which they observe. This allows them to affirm their location, physically and metaphorically, within the white ideals of objectivity and truth. The power they hold over black bodies is top down as the physically constructed systems of surveillance feed into a social power paradigm. The surveillance is revealed to be "not [solely] about 'crime control' but rather about 'control' in a wider sense" (5). Those within the white space are granted free reign over those within the black space, thus asserting them as both a savior and a master; the administrators ostensibly protect those within the space, but more so they discipline them. Such a dynamic raises the question that Hille Koskela asks in her essay on surveillance: "who has the right to look, and who will be looked at" (5)? In Camden, the power in this hierarchy of looking rests firmly with the predominantly white bodies of the county administrators. As with other cities that are highly surveilled, however, many systems are being digitized; in Camden, new squad cars are installed with license plate scanners that automatically determine crimes associated with vehicles the car passes. Facial recognition systems are also becoming ever more present in visual surveillance apparatuses. These new technologies are suggestive of a larger turn towards automated "Minority Report-style" law enforcement (11). How do the dynamics shift as we move into an age wherein an increasing number of processes are digitized? Will such a change help correct for the process of racialization or simply reinforce it?

Part III: Technological Domination

Within a video surveillance apparatus, an image is captured of a body and transmitted to an administrator's screen for observation and judgment. This digitized body is leaky; sweat, clothing, biometrics, and even pre-recorded metadata are swirled together to create a virtual assemblage upon which the observer may assign racialized presuppositions. The body is simultaneously de- and re-contextualized as a technological object frozen in time; it no longer exists as the body at the moment of capture and now takes form only in the virtual space of the recording device. Due to the inability to extract context beyond that which has been captured, it is inevitable that biases will be applied to the body during the transmission of its image. The body will be judged based upon the observer's associations of observable traits with risk factors; as Andrew Ferguson says "[e]ven as code, the data is still black" (12). In light of empirical affirmation that "whites systematically overestimate the relationship between black [people][4] and crime," it seems that such a judgment will often fall along racial lines (13). Criminal justice scholars pose a move towards "objective" computerized systems of surveillance

and sentencing as a mode through which to correct these biases. Are they accurate in these assertions, or will computer models simply reinforce the same racialized judgments? It is necessary to examine how, and under what conditions, these technologies will be developed.

It is apt to ask the question that Wendy Faulkner addresses in her essay on technology — "how is technology gendered?" — but to recast it through the broader lens of "how is technology biased" (14)? Faulkner sees technology, within which surveillance is included, as developing within an existing societal power dynamic. It follows, then, that this development would certainly be a "'co-production of gender and technology,'" but also one of race, class, etc. and technology (14). As such, it follows that a technology produced by and for a police/criminal justice state would have inscribed into it the biases already perpetuated by said state. Empirical grounding for Faulkner's assertion is found in recent research that shows that datasets for facial analysis algorithms are disproportionately composed of lighter-skinned bodies. This leads to a much higher error rate when attempting to classify traits, such as gender, for dark-skinned or black-bodied individuals (15). Such miscategorizations can lead to very problematic errors within law enforcement. If facial recognition software is used within a surveillance system and tends to miscategorize black bodies, then homogenization and categorization of black bodies as criminal may occur. The technology reifies the association of blackness and criminality as it groups and, potentially erroneously, assigns criminality to the images it captures. Such errors (re)inscribe a "human" racial bias within a technology ostensibly built to control for such biases. The project of racial domination detailed in the former section is not eliminated but instead reconstructed within a digital space. That many of these algorithmic processes are performed within "black box" systems — technological systems with little to no transparency in their operation — only compounds the issue. Without a turn towards a model in which the decision-making process of algorithmic systems is revealed and there exist "mechanisms to test whether the computer system works designed", there is limited accountability for those that ignore race (12). There must be a push to research and critique the implementation of automated technologies in criminal justice enforcement, with specific attention paid to the impact and history of racialization in such systems.

Conclusion

In a system where bodies are disproportionately surveilled and regulated, it appears there is a great need for additional research on the relationship between surveillance and race. A critical reframing of Foucault's Panopticon exposes and corrects the omission of race from its design. Panoptic surveillance systems decontextualize bodies and reduce them to their physical form. In this process, they may amplify already existing patterns of subjugation and racial domination. When attention is paid to

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2. As of 2010, the major racial groups (over 10% of the population) in the City of Camden were as follows: 48% African-American, 47.04% Hispanic/Latino of any race, and 17.59% White may encompass some Hispanic/Latino people due to the classification system used by the US census) (10).
3. As of 2010, the major racial groups (over 10% of the population) in Camden County were as follows: 65.29% White, 19.55% Black or African American, and 14.24% Hispanic/Latino of any race (10).
4. I have changed the word "neighbors" to "people" for the sake of this essay because I feel that the qualifier is unnecessary. Though the research focuses on white people's perceptions of their own neighborhoods, it seems fair to apply the findings beyond that space.

adverse effects upon already marginalized groups, the lack of empiricism beyond crime-reduction based efficacy measures is troubling. The invisibilization of racial dynamics within surveillance studies placates those who benefit from their place in a social hierarchy. The possibility, and in some cases the reality, of technological domination becomes ever more apparent as control of surveillance operations is turned over to machines. A 2015 CNN article posed the question "Is Camden a model for the future of policing" (16)? Without a great deal of further scholarship, any answer to this question other than "no" seems rather concerning.

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Evolution in Action:
A review of Ideonella sakaiensis

Paige Allard

Introduction

The discovery of the polyethylene terephthalate (PET) degrading bacteria *Ideonella sakaiensis* 201-F6 has exciting implications for the future of recycling as well as bioengineered bioremediation of plastic pollutants abundant throughout the environment. This review intends to highlight the discovery of this bacteria including how researchers identified the enzymatic cascade through both its biochemical properties and its genetic underpinning. Furthermore, this review intends to report, using the 3-D structure of the key enzyme PETase, how the enzyme evolved to such a high efficiency in comparison to the enzymes closest homolog. In addition, this report will describe the potential for engineering to become even more efficient. Finally, this review will outline the applicability of the *Ideonella sakaiensis* 201-F6 bacteria and its unique enzymes in both industrial recycling processes and its potential for use in environmental bioremediation, with a focus on marine plastic pollution.

Background

Plastics are synthetic polymers that are lightweight and extremely durable, making them an exceptionally useful material. The annual production of plastic has increased from 1.7 million tonnes in the 1950's to 322 million tonnes in 2015 (1, 2). The abundance of single-use plastic products coupled with poor waste management has led to copious amounts of plastic littered throughout the environment. The majority of plastics still have an unknown degradation period, as few enzymes can break down the covalent bonds in their polymer chain. The limited degradation of plastics has led to a large accumulation of plastic pollution, expected to reach 30 billion tonnes by 2050 (3). Polyethylene terephthalate (PET) plastic is the third-most produced plastic, with ~56 million tones produced in 2013 alone (4, 5). PET is commonly produced for water bottles and food packaging (5). This type of plastic contains a high ratio of aromatic compounds, making it chemically inert and therefore impervious to most microbial degradation (4).

Discovery

A study was published March of 2016 outlining the findings of Japanese scientists who discovered a bacterium which can degrade and assimilate polyethylene terephthalate (PET) (4). Researchers isolated microbes found in soil and sediment samples from a highly contaminated area located just outside of a plastic bottle recycling depot. They screened the samples for microbes with machinery, such as extracellular appendages, suitable for degradation of PET and cultured them in the presence of thin PET films (20mm x 15mm x .02mm) (6). The researchers discovered the novel species *Ideonella sakaiensis* 201-F6, which had the ability to degrade the surface of the PET film (4). This discovery was based on the finding that the cells were connected to the film via short appendages, suggesting degradation to be facilitated through this possible mechanism of enzyme delivery. They also observed additional appendages connecting the cells themselves (4).
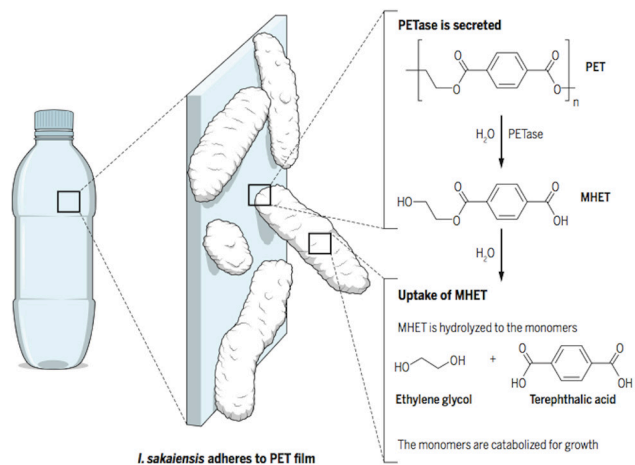

Figure 1: *Ideonella sakaiensis* is able to use PET plastic as an energy source due to two enzymes: PETase and MHETase. The gene coding for PETase has been found to be upregulated in the presence of PET plastics. Figure sourced from Bornscheuer (9).

The bacteria were found to be able to nearly fully degrade the film after 6 weeks at 30°C. After biochemical analysis, it was determined the bacteria first break down the PET into primarily monomeric mono-2-hydroxyethyl terephthalate (MHET). A secondary enzyme is then produced that breaks down MHET further into terephthalic acid and ethylene glycol, which the bacteria

are then able to use as a source of energy (4).

To determine the genetic basis for the PET degradation process, a draft sequence for the *Ideonella sakaiensis* 201-F6 genome was constructed using the Illumina Genome Analyzer and published in the National Center for Biotechnology Information taxonomy database (4). An open reading frame (ORF) ISF6_4831 coding for an enzyme was identified to hold 51% amino acid sequence identity with an enzyme isolated from *Thermobifida fusca*, another bacteria known to exhibit PET-hydrolytic activity (4). This protein was then isolated and incubated with PET film for 18 hours at 30°C, resulting in some degradation to the PET film. These findings confirmed the role of ISF6_4831 in the hydrolysis of PET, and the protein was subsequently termed 'PETase'. In addition to the genomic sequencing, RNA was sequenced to analyze the transcriptome of *Ideonella sakaiensis* 201-F6 (4). The cells were cultured on several media including TPA-Na, maltose, BHET and PET film. The PETase coding gene was found to be substantially upregulated when cultured on the PET film, suggesting that PETase expression is directly induced by the presence of PET plastic (4). A second gene for ISF6_0224 protein was found to be similarly expressed to PETase in each of the media. The sequence was homologous to the tannase family, which hydrolyzes the ester linkage bonds of aromatic compounds. Once purified the protein was able to hydrolyze MHET with extreme efficiency into terephthalic acid and ethylene glycol. The protein was therefore termed MHETase (4).

Phylogenetic analysis through enzymatic structur

PET plastics have only become a persistent environmental pollutant in the past 50 years (8). It is likely that that the evolution of *Ideonella sakaiensis* 201-F6 to degrade PET would only have occurred in response to the substrate becoming widely available in the environment, making the PETase enzyme a rare example of rapid evolution. There have been several cutinases belonging to the a/b serine hydrolase family found to hydrolyze PET (see Table 1; 3). However, PETase has a much higher reactivity with a reported 5.5 – 120-fold higher efficiency than the previously discovered enzymes. Most of these other enzymes are not functional at the moderate temperature of 30°C they require a high temperature in order to activate (7). The high sequence identity between the PETase and other PET-hydrolyzing enzymes suggests conserved specificity for substrate binding.

Species	Enzyme
Thermobifida fusca DSM43793	T*f*H and T*f*H BTA-2
T. fusca KW3	T*f*Cut1 and T*f*Cut2
Saccharomonospora viridis AHK190	Cutinase
Thermomyces insolens	*Hi*C from
Candida antarctica	Lipase B
Metagenome in plant compost	LC cutinase

Table 1: Species which exhibit PET degrading capabilities with the following enzymes (3).

Examining and comparing the structure of other enzymes of similar function can provide insights into the evolved mechanisms of the PETase enzyme. For example, a study by Austin et al. (2018) used long-wavelength X-ray crystallography to determine the structure of PETase. This study found the enzyme consists of an a/b hydrolase fold, which is expected given its sequence identify to other PET cutinases such as the cutinase from *Thermobifida fusca* (8).

Although the *Thermobifida fusca* cutinase holds 52% sequence identity with PETase and similar folding and structural morphology, Austin et al. (8), surprisingly, found the surface profile of PETase to be drastically different. Like other cutinases, *T. fusca* has random sections of both acidic and basic residues which result in the surface having a mostly neutral charge (see Figure 2D; 8). The isometric point of the T. *fusca cutinase* is 6.3, which is determined by the pH necessary for the net charge on the protein to be zero. In contrast, PETase exhibits a dipole caused by its highly polarized surface charge and has a much higher isometric point of 9.3 (see Figure 2C). Further research will be necessary to determine if the unusual surface charge of PETase, in comparison to its homologs, plays a role in the enzymes increased degradation efficiency (8).

In addition to the evolved surface charge, PETase has also adopted a broader active-site cleft, approaching three-fold width of the *T. fusca cutinase*. Austin et al. (8) hypothesize the broader active-site is crucial to the binding of the semi-aromatic PET. The authors determined this change to the active-site cleft evolved from a single amino acid mutation from phenylalanine to serine in the lining of the active-site (8).
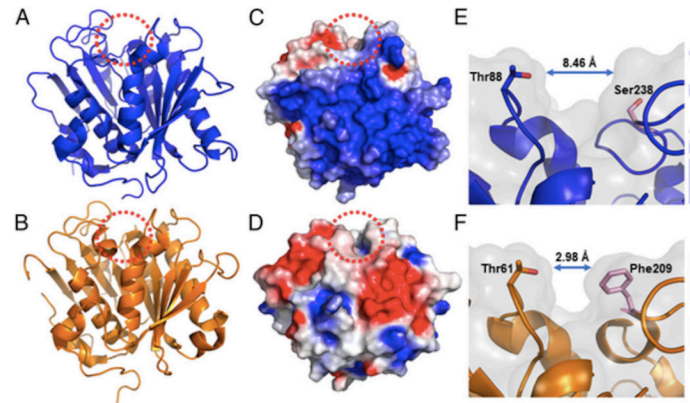

Figure 2: Comparison between PETase protein structure and PET degrading cutinasefrom *Thermobifida fusca*. A) Visualization of PETase protein at 0.92 Å resolution, the red dotted circle indicates the active-site cleft. B) Visualization of *Thermobifida fusca* cutinase for comparison, the red dotted circle indicated active-site cleft. C) Electrostatic potential of PETase surface color gradient represents red as acid and blue as basic. D) Electrostatic potential of *Thermobifida fusca* cutinase surface color gradient represents red as acid and blue as basic. E) Zoomed in depiction of the active-site cleft of PETase. F) Zoomed in depiction of the active-site cleft of *Thermobifida fusca* cutinase. Image sourced from Austin et al. (8).

To test this they created a mutant, which was intended to 'de-evolve' the enzyme and return it back to a common type cutinase. To the researcher's surprise, this mutation actually improved binding affinity, which is hypothesized to be due to optimized proton shuttling (8). The mutant PETase performed 20% more efficiently than the wild type in the degradation of polyethylene furanoate (PEF) films. Because the PEF polymer is chemically very similar to PET, researchers wanted to test its ability to degrade a wider array of polymers. The significance of this finding is that the PETase enzyme has only recently evolved meaning it has not yet reached its full potential, leaving more room for optimization in its biomechanical functioning (8). This finding also opens the door to exciting avenues of environmental bioremediation of PET plastics using the PETase enzyme.

Future directions

The discovery of *Ideonella sakaiensis* 201-F6 has opened many doors for research in the bioremediation of plastic contaminants. As the reactivity of the PETase enzyme is much higher and can operate at a moderate temperature, enzymatic industrial remediation is now a possibility that was not attainable with previously-discovered enzymes. There are two avenues in which this enzyme may be used in future applications. First, one of the costliest steps in PET plastic production is the raw petroleum materials needed, which are terephthalic acid and ethylene glycol (9). The enzymatic breakdown by PETase would serve as a functional bio-recycling process in which the raw materials can be reused for new polymer production. This system could potentially result in increased recapture of PET material as higher incentives can be provided to reclaim the costly monomers. A second area of application is in environmental remediation. There was an estimated 8 million metric tons of plastic that entered the ocean in 2010 alone (10). PETase and MHETase enzymes produced by *Ideonella sakaiensis* 201-F6 could be a potential solution to alleviating this extensive marine pollution (10). Plastics, when exposed to the elements fragment into small particles known as microplastics (particles <5mm; 11). These small particles have become an increasingly serious ecological threat as they can be easily distributed by ocean currents and incorporated into the oceanic food chain, causing negative impacts to a variety of marine life (11). Microplastics are not accessible to traditional means of marine plastic removal such as booms or nets as their small size causes the particles to slip through capture. If these conventional capture technologies were altered to remove microplastics, they would also strip the water of living microorganisms, such as plankton, which are crucial to marine ecosystems (11). Using bioremediation techniques is the only way to combat these harmful plastic particles without disturbing the abundant small organisms within ocean water samples. Genetically modifying the *Ideonella sakaiensis* bacteria would make it a candidate for exploring the possible bioremediation of plastic contaminants in the environment, specifically of microplastic in the ocean, and may be the only way to do so with the least amount of ecological disturbance. The desired outcome would be an organism that could withstand ocean temperatures and conditions, bind to the plastic and produce the necessary enzymes to degrade PET plastic, while not harming existing ecosystems.

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Simonetta Vespucci:
A Socially Constructed Multidimensional Character in Renaissance Florence

Thea Solbakken Sæterdal

A Botticelli's *Idealized Portrait of a Lady* is a portrait that commonly goes by one of three names; *Portrait of Simonetta Vespucci, Portrait of Simonetta Vespucci as Nymph*[1] and *Idealized Portrait of a Woman (Figure 1)*.[2] The portrait has been examined in great detail by several art historians since its creation in ca. 1480-1485, but all questions and speculations regarding the identity of the sitter in the painting were largely discredited until Aby Warburg wrote a compelling argument in 1992 for why Botticelli may have been portraying Simonetta Vespucci in this particular work (1). Since then, a new trend of research started as historians tried to argue for and against the identity of the sitter, and in the more contemporary part of the conversation, there has been a shift towards analyzing the larger body of poetry and paintings that appear to be linked to Simonetta Vespucci in an attempt to understand the complex body of work as a whole (1).This paper aims to contribute to that conversation by arguing that the *Idealized Portrait of a Lady* is a representation of a socially constructed character, grounded in the real Simonetta Vespucci's person, but idealized and fictionalized through the larger body of poetry and paintings associated with Simonetta at the time. Instead of trying to present a dichotomizing argument, I hope that this text will rather allow for complexity and foster a conversation about Simonetta's purpose as a character for painters and poets in Renaissance Florence.

Although most of the evidence of Simonetta's day to day life has been lost, her existence and general appearance has always been generally accepted. Simonetta Vespucci was born in 1453 in Genoa (2) and spent most of her life in Florence before she passed away in 1476 at the age of 23 (3). Simonetta Vespucci's identity is commonly confirmed through many physical descriptions from poets such as Angelo Poliziano:

Poliziano, I:
"Her skin is pale, her hair flowing and golden (1.43.1-4), and her lips and teeth resemble red violas and pearls (1.50.5). (…) Simonetta's sweet and joyful nature is such that the 'dolce sereno' of her eyes calms the air around her (1.44.1-4) (4).

In Figure 1, we can see the direct resemblance between Poliziano's physical descriptions of Simonetta and Botticelli's painting. In the painting, the lady's skin is quite pale, almost reminiscent of porcelain. The hair is strikingly golden, an illusion created with effective highlights painted within the strands of the hair giving the appearance of a golden shine. Although restricted in some braids, the hair is painted as soft curls which also fits with Poliziano's "flowing" description. The flowing movement is particularly evident in the tassels of hair at the end of the smaller braids on the side of the lady's face, as the transition between the braid and the free-flowing hair suggests that unless her hair is forcibly constrained through braids it will naturally appear large and wavy. Her calm eyes in Poliziano's description also matches the painting where the eyes appear soft due to her eyelids being painted partially closed. Other popular descriptions of Simonetta include her red viola lips and golden-brown eyes, which are also evident in the painting. Her eyes are one of the most important features used to identify works of poetry or painting of Simonetta as the color of her eyes is different from what was considered the most beautiful at the time. The famous Baroque painter Pietro Testa working within the Vernacular style expresses in one of his painting notes that the ideal eye color is "dark chestnut," a view also reflected by Petrarchian writers such as Giovanni Boccaccio in *Famous Women*, Agnolo Firenzuola in *On the Beauty of Women* and Francesco Petrarch in his poetry (5). This suggests that Botticelli's painting is portraying an idealized version of a woman, while still choosing to keep some of the characteristic elements of 'the real Simonetta Vespucci'.

After establishing that Botticelli's *Idealized Portrait of a Lady* can be loosely linked to textual descriptions of Simonetta Vespucci, the next questions are: under what conditions were the textual evidence created and to what extent did the portrayals in text and painting depict general Petrarchan ideals of beauty as opposed to a more realistic portrayal of the real woman that was Simonetta? The contextual information important to this discussion is that after Simonetta's early death, several famous writers such as Lorenzo de' Medici, Angelo Poliziano, Luigi Pulci,

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1. I have purposely decided to exclude the question of Simonetta representing a nymph for the scope of this essay.
2. In this essay, the painting will be referred to as Idealized Portrait of a Woman as this title takes into account the ambiguity of the representation of Simonetta Vespucci in the portrait.

Bernardo Pulci, Girolamo Benivieni, Tommaso Sardi and Francesco Nursio Timideo all wrote poems, sonnets, elegies or epics that mentioned or can be associated with Simonetta (4). In many ways, Simonetta became a cultural phenomenon, and there was a sense of competitiveness in the creation of poetry about her around the time of her death (4). This is important for the discussion of Botticelli's painting as the painting was created c. 3-8 years after Simonetta's death. Let us for instance again look at some lines from Angelo Poliziano in comparison to some lines from the man whose poems set the standard of beauty in Renaissance Florence, namely Petrarch:

Poliziano, II:
Her eyes do not merely shine, but flash with the fire of Cupid's torches (I.44.1-2);
(…) it [her gaze] could move mountains or stop the sun in its tracks (I.50.2); and everywhere the weightless sensuality of her movements is stressed. (…) Radiant with beauty, joy and love (…) (4).

Petrarch:
Those lovely eyes, that struck me in such guise
that only they themselves could heal the wound,
and not the power of herbs, nor magic art,
nor some lodestone from far beyond our seas (6),

These short sections explore the power of a woman's gaze. In Poliziano's first line he comments on the divine aspect of Simonetta's gaze, and the second line claims that the eyes of the idealized woman possess an extraordinary power. This notion of the eyes of a woman as a window into the divine was an idea created by Petrarch, which reappears in several of his poems (6). Petrarch also mentions the ethereal power of a woman's gaze to heal wounds that no earthly powers can heal. There are clearly parallels between the two writers' description of a woman's eyes. When we look back at Bottecelli's work (Figure 1), the eyes of the lady share a similar gaze, created through the inclusion of white paint on the iris of the eye that manifests as a shine or a flash of light in the eye. The ethereal and unobtainable gaze that Petrarch comments on is also demonstrated in the angle of the sitter in Botticelli's painting. The body of the lady is angled slightly away from the viewer, making her gaze unobtainable, as Love, in Petrarch's poems, is something that he is hopelessly striving for, but can never fully get. The parallel between the eyes of Petrarch's idealized woman with the depictions of Simonetta by Poliziano and Botticelli is therefore evidence of Simonetta being idealized to some extent by the poet and painter.

In his book, *On the Beauty of Women*, Agnolo Firenzuola also discusses Petrarchan beauty ideals in Renaissance Florence. The book, which was popular at its time, tells us about the desire for golden hair, white skin, a long neck and black eyes, which also fits into the description of Simonetta if one ignores the ideal color of the eyes (7). Later in the dialogue Agnolo gets to the core of what he believes beauty, in its many forms, is. Looking back at the lines of Poliziano, II, Simonetta's beauty is contemplated with a focus on her weightless movements This is very similar to the idea of beauty as "charm," which Agnolo refers to as the idea that

beauty is movement that causes a man to reflect in the presence of a lady (6). In Botticelli's portrait (Figure 1) the lady appears as if she is floating forward, where the implied motion is found in the diagonal line from the shoulder and all the way up her neck, the wavy hair exaggerates the motion. The motion appears to be going forward in a floating manner, as opposed to a bouncy up and down fashion, due to the seemingly weightless and untouched structure of the waves in the lady's hair. This untouched and weightless appearance may also reflect Agnolo's description of beauty as loveliness, defined by virtuousness and loftiness, as the lack of weight in the portrait elevates the subject which makes it appear more virtuous and noble (6).

This discussion highlights that Petrarchan beauty ideals did in fact influence the cultural foundation that poets used to describe Simonetta Vespucci, which appeared around the same time as Botticelli's *Idealized Portrait of a Lady* was painted, namely in the years following Simonetta's death. Now that we have considered some of the evidence of the Petrarchan influence on poems of Simonetta in relation to Botticelli's painting, we must then ask if there is evidence in the painting itself that suggests an idealization or etherealization of the lady in question.

Let us first start by comparing Botticelli's *Idealized Portrait of a Lady* (Figure 1) with two of his other portraits, namely *Portrait of a Lady Known as Smeralda Bandinelli* (Figure 2) and *Portrait of a Young Lady* (Figure 3). The reason for looking at these three examples is that they are all portraits by Botticelli painted only a few years apart, and all generally accepted as portraits of real ladies in Florence at the time (source?). The most prominent difference between the three paintings is the lack of a background in Botticelli's *Idealized Portrait of a Lady*. In the Renaissance, the backgrounds of paintings can be used both to identify the time the painting was created and tell us something about the how the painting was supposed to be understood. Botticelli was a master of backgrounds (8), which regularly would include architectural elements in portraits (such as in the example of Figure 2 and 3), that situate the subject within the mortal world. In the case of Figure 2 and 3, the subjects are placed inside a building, which implies the women's place within the home. By consciously choosing to leave the background black in Figure 1, Botticelli therefore chose to portray the woman in Figure 1 as existing in a space outside of the common world, whereas the ladies in Figure 2 and Figure 3 are situated within the real world.

The second difference between the three paintings is the abundance of pearls in *Idealized Portrait of a Lady* in comparison to the two other paintings. The ladies in Figure 2 and Figure 3 are not wearing any pearls, but this can simply be explained by the portraits not portraying ladies with a social ranking that would warrant pearls. This does not mean that the pearls in Figure 1 can be explained by Simonetta's societal standing, for although she was an upper-class woman in Florence, sumptuary laws would have prevented her from wearing such an abundance of pearls in her hair and dress even if she could have afforded it (8).[3] This

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3. During the Renaissance, there were strict sumptuary laws regarding the number of gems and fabrics women could adorn themselves with at different times of their lives. The number of gems and the types of fabrics was understood as a direct reflection of the wealth of a woman's family, or more specifically the wealth of her husband.

suggests that Botticelli painted the lady not as a realistic portrayal, but rather as an idealized portrayal of a lady in which he showed off her ethereal qualities through material opulence and beauty.

The ethereal aspect is also confirmed by looking at the differences in the body position of the three paintings. Figure 3 is a classical profile portrait where the lady is perpendicular to the viewer. Figure 2 is directed at the viewer with a direct eye-contact that challenges the viewer to interact with the subject of the painting. Figure 1 is somewhere in between where the body of the subject is rotated toward the viewer at an almost 3/4 angle, which invites the viewer to look at the pearls decorating her chest, the intricate lace on her dress, and the blue steel-like material that resembles a breast-plate. The head, however, is almost positioned at a profile angle, but tilted slightly toward the viewer, which makes the subject appear to be somewhat engaged with the viewer, but the lady still holds the power as she is not letting the viewer look her directly in the eyes. The aforementioned breast-plate stands out in the portrait and could be connected to the story of the Greek goddess Athena. This interpretation is significant as E.H. Gombrich and other art historians have already argued for Botticelli's Neoplatonist beliefs and use of symbolism in several other paintings (9). Athena is often recognized by her amour, and the polished steel-blue feature on the lady's dress in the painting could easily be interpreted as a homage to the Greek myths (10). Although Neoplatonist symbolism in Botticelli paintings are often considered enigmatic, the enigmatic nature of the symbolism in itself suggests that there is room for interpretation and that the portrait was not intended as a realistic portrait (9).

Following the death of Simonetta Vespucci, the sheer number of poems and paintings created a large influx of interpretations of who Simonetta was and what she looked like. This led to the formation of a socially constructed character of Simonetta Vespucci, that that expanded into myths and had an etherealizing effect on her image. It was in this fictional sphere that Botticelli created his *Idealized Portrait of a Lady*, making her a portrait close in appearance to that of the 'real Simonetta Vespucci,' but fictional by nature as constructed by the Petrarchan poets in Renaissance Florence at the time.

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Figure Captions

Figure 1:

Sandro Botticelli, Idealized Portrait of a Lady, c. 1480-1485. Tempera on wood, 82 x 54 cm.

Image from Google Arts and Culture: http://www.artsandculture.google.com

Figure 2:

Sandro Botticelli, Portrait of a Lady Known as Smeralda Bandinelli, c. 1479. Tempera on panel, 65.7 x 41 cm.

Image from Google Arts and Culture: http://www.art-sandculture.google.com

Figure 3:

Sandro Botticelli, Portrait of a Young Lady, c. 1475. Tempera on wood, 41 x 61 cm.

Image from WikiArt Visual Art Encyclopedia: http://www.wikiart.org

Improving Programmatic Assessment:
A Participatory Approach

Lauren Bauman and Ellen Flournoy

As program-level assessment[1] increasingly becomes an integral part of the higher-education landscape, so does the debate regarding the efficacy of current assessment methods. Although program assessment is a recognized "best practice," it is also widely accepted that current methods are flawed; investments in program assessment are not yielding the desired results. David Eubanks, an "assessment insider," described some of these concerns in an article published by the Association for the Assessment of Learning in *Higher Education* [1]. The three concerns highlighted by Eubanks revolve around methods of collecting and analyzing data. Many institutions choose to (1) collect either big sets of data that are too superficial or deeper data in sets that are too small, (2) analyze decontextualized data that doesn't take student differences into account, and (3) make decisions using data that was collected in ways that result in validity and reliability concerns. Critics of program assessment wonder why we waste our time collecting and analyzing data if no useful or reliable information can be gleaned from the process. We challenge these concerns about traditional assessment by addressing some of the issues raised by Eubanks and by reimagining the data collection process as an opportunity for collaboration and learning between faculty and students.

Traditionally, students don't participate in assessment—neither of their own learning nor of institutional or program efficacy. Program-level assessment data would traditionally be collected by embedding questions in student evaluations, such as essays, research projects, or final exams. We assert that lack of student participation in assessment is not only a missed opportunity for student learning but also a missed opportunity for the institution to acquire authentic, contextualized evidence that would improve the assessment process. Furthermore, collecting programmatic assessment data in this way, without the students' knowledge, strips their agency to actively participate in the program assessment process. By shifting this process, we present an alternative to traditional program-level assessment methods. Our proposed process generates more insightful data with less time and financial investment than traditional assessment models while increasing student autonomy, participation, and learning.

This collaborative alternative is meant to improve student learning in two ways: (1) by asking students to reflect on their achievement of learning outcomes using evidence-based methods; (2) by providing assessment practitioners with authentic, contextualized data on which to make claims about curricula. Using a simple survey, students are guided through a process that asks them to self-assess their achievement of the intended learning outcomes, provide evidence of their achievement, and then reflect on their learning. The survey is conducted during class time and follows from a discussion on reflective based self-assessment and program assessment. During the discussion, students are encouraged to make connections between assignments, activities, projects, and the program learning outcomes. The discussion helps students solidify the content and skills acquired through their courses, and the survey models a form of evidence-based self-reflection.

The process described above is designed to benefit student learning by aligning with decades of research supporting reflective practices in learning [3, 4, 5, 6, 7]. Reflection is shown to increase students' awareness of their own learning process, learning difficulties, and the need to develop strategies to address these difficulties [8]. Further, a synthesis of the research shows that most studies of reflection in higher education cite an "enhance[ment of] learning and overall personal and professional effectiveness" [6] as the outcomes of reflection.

After the surveys are completed, responses are compiled and validated through an emergent coding scheme that identifies major patterns in data. We assess to what extent the learning outcomes are being met by examining the students chosen evidence and their explanation of how that evidence relates back to the learning outcome. Student responses also offer insightful information into their learning experiences which can be used to inform future practices.

Not surprisingly, some of our limitations align with the broader programmatic assesment concerns previously presented, maininly the lack of statistical validity and contextualized data

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1. Program-level (or programmatic) assessment refers to assessment of a program, not the assessment of an individual. For the purposes of this project, we define assessment as "a process in which rich, usable, credible feedback from an act—of teaching or curriculum—comes to be reflected upon by an academic community, and then is acted on by that community—a department or college—within its commitment to get smarter and better at what it does" [2]. This definition is useful as it stresses three crucial aspects to all assessment: feedback, reflection, and action.

analysis. We contextualize our data by allowing students to provide an explanation of their evidence; however, this approach limits our context to what each student deems important. Due to a lack of resources for assessment, our institution does not collect students' background information, such as gender, age, nationality, or past schooling (ex. transfer student), so our data collection cannot be traditionally contextulized. Nonetheless, student's explanations in the survey and their awareness of the assessment process allows them space to explain their contextualized realities. In many cases, we are able to determine from explanations not only if but why a misunderstanding has occurred. Further, we acknowledge our data is qualitative in nature and our analysis relies on our development of a code that we feel best represents the data. Consequently, our positions as assessors inevitably influences our interpretation of students responses. To counteract our biases, we go through many rounds of independent coding, requiring discussion and consensus when coding is not aligned. Most importantly, always considering our limitations within the context of research-based concerns ensures we constantly reflect on our process, present our results transparently, and communicate the potential challenges of implementing this system. Ultimately, we never use percentage gains to make value added arguments or claims about our students and instructors. Our work is driven by the goal of improving student learning and implementing effective program development.

After three years of implementing our assessment surveys, we have seen them as helpful to both students and faculty but also recognize their limitation and believe they are inadequate on their own. A more rigours assessment process would combine other assessment methods, multiple types of data, and provide more conclusive results. However, for insitutions that wish to incorporate students into all parts of their assessment cycle, we present this approach as a potential starting point.

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How computation and a rare disease can teach us about Basic Biology and Cancer

Michael Geuenich, Johanna Rommens & Marina Tourlakis

Introduction

The central dogma of molecular biology describes the flow of information in a cell from DNA to RNA to protein. The basic components of DNA and RNA are nucleotides, and the main difference between the two is their structure: DNA forms a double stranded helix, while RNA is single stranded. RNA is created using DNA as a template in a process known as transcription. The basic components of proteins on the other hand are made up of molecules known as amino acids, and they are created by 'translating' the RNA sequence into amino acids in a process appropriately termed translation.

Translation is performed by a piece of molecular machinery known as the ribosome. The function of the ribosome is to decode the RNA sequence and to form a chain of amino acids based on this template, which will subsequently form a functioning protein. Translation itself is a process that is conserved throughout all of life, and a deregulation in it has been associated with cancer as well as several inherited diseases. Thus, the study of translation is relevant for our understanding of life, cancer and other inherited diseases.

Shwachman-Diamond syndrome

One of the approaches used to understand basic biological processes like translation is to study diseases caused by impairments in the process and to characterize these on a molecular level. In the case of translation, one of these diseases is Shwachman-Diamond syndrome (SDS), a rare disease affecting around one in 76,000 people (1). SDS is caused by defects in ribosome biogenesis (the creation of ribosomes), and is characterized by a cumulative risk of leukemia of around 36% by the age of 30, pancreatic insufficiency leading to digestive issues, short stature and cognitive impairment among others (2–5).

Specifically, SDS is caused by defects in ribosomal subunit joining. A fully functioning ribosome is composed of a large subunit (termed the 60S) and a small subunit (termed the 40S). Both subunits are made within the nucleus of the cell and they are then exported separately into the cytoplasm, where they go through several final maturation steps before they join and initiate translation, forming a functional ribosome. To prevent their premature joining, the eukaryotic initiation factor 6 (eIF6) blocks both subunits from doing so. Once both subunits are mature, eIF6 is removed from the pre-60S subunit by two other proteins: elongation factor like 1 (EFL1) and Shwachman-Bodian-Diamond syndrome (SBDS) (fig. 1). In about 90% of the cases, mutations in the SBDS gene have been shown to cause SDS, although the exact mechanism by which they lead to disease is still somewhat unclear (6,7).

Early attempts at elucidating important sections of SBDS identified 159 homologous SBDS protein sequences in other organisms (8). Functionally important sections of SBDS were identified under the premise they would be conserved across species, while less important sections would vary more widely. Furthermore, no bacterial SBDS sequences were found. Since this initial analysis, twelve years have passed, and the number of publicly available sequences has increased 40-fold (9). Thus, a renewed search for SBDS was conducted to confirm the likely absence of bacterial SBDS, and to gain a more refined understanding of the variance of this critical protein across species.
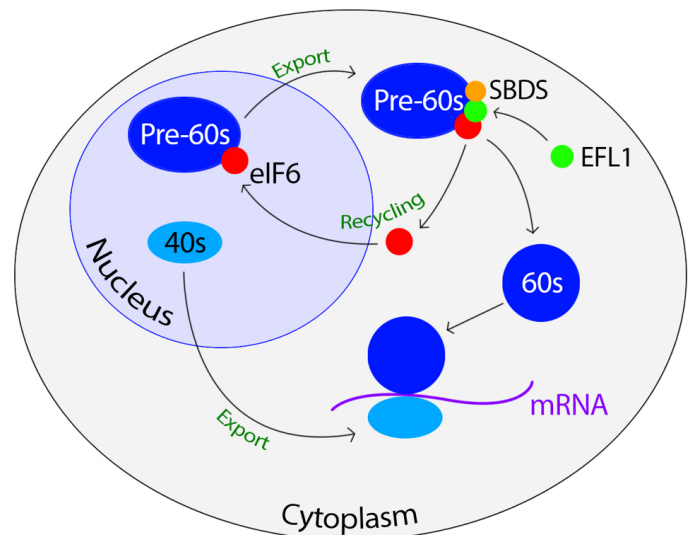

Figure 1. Illustration of the final steps involved in ribosomal subunit joining. The pre-60S subunit is exported with eIF6 attached. SBDS and EFL1 remove eIF6 allowing for the formation of a mature 60S subunit. The mature subunits then assemble on the mRNA strand, initiating translation.

Methods

Sequences were identified using the Basic Local Alignment Search Tool (BLAST) (10), a computational search tool for genomic sequences with the *Homo Sapiens and Arabidopsis thaliana* SBDS sequences against the RefSeq, non-redundant and transcriptome databases provided by the National Center for Biotechnology Information. To allow for comparisons between sequences, multiple sequence alignments (MSA) were created using MUSCLE (11) with standard parameters. All MSA's were built and visualized using Jalview (12).

Results

Given that no bacterial SBDS sequences have been reported and that bacteria lack a homologous eIF6 protein (13), we expected to confirm the absence of SBDS in bacteria. Indeed, no bacterial SBDS sequences were identified.

Comparisons between eukaryotic and archaeal SBDS sequences revealed a conserved section in eukaryotes that was missing in archaea (fig. 2). The first amino acids in the H. sapiens SBDS sequence (serine 2 – valine 15) are thought to interact with the peptidyl-transferase centre of the ribosome 14, the area responsible for joining individual amino acids. This section is largely conserved in eukaryotes, while it is largely missing or different in archaea.
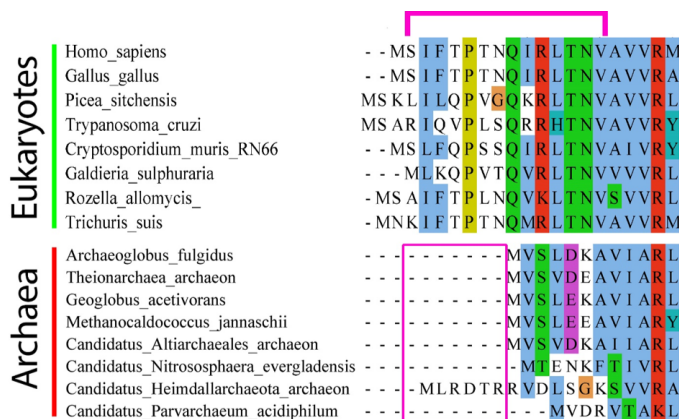

Figure 2. Multiple sequence alignments of the beginning section of SBDS in eukaryotes and archaea. The section thought to interact with the peptidyl-transferase centre is highlighted with a bracket. The missing section in archaea is highlighted with a pink box.

Discussion & conclusion

Previous studies have reported the absence of bacterial SBDS, however, only 228 bacterial genomes had been sequenced at the time 8. The present renewed search for bacterial SBDS using computational method across the over 50,000 available bacterial reference sequences 9 confirmed the absence of SBDS in bacteria.

The conservation of amino acids serine 2 – valine 15 in eukaryotes suggests an important function of this section in eukaryotes, consistent with the proposed interaction with the peptidyl-transferase centre (14). The fact that this section is missing in archaea suggests that this process is unique to eukaryotes. Further studies are required to confirm the exact role of this sec-

tion and to elucidate why it is unique to eukaryotes.

Overall, this study can serve as an example that a renewed examination of early studies can further elucidate the function of a protein given the large increase in available sequences and additional functional information of the protein itself.

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Evaluating Impacts of Trails on Subalpine Vegetation:
Wheels, Feet, and Where the Trees and Sky Meet

Tully Henke

Introduction

Use of backcountry areas is restricted to certain activities. Some areas legislate specific requirements (e.g. non-motorized access) while others are simply unsuitable for all but a few activities. Developments in technology and societal increases in outdoor recreation are putting pressure on these restrictions and on backcountry areas in general [1, 2, 3]. Certain areas are experiencing transport based increases in access (e.g. helicopter access), others are experiencing overall increases in backcountry users, some are experiencing both [4, 5].

The potential impacts of this sort of use are particularly important to consider in the Sea to Sky region of British Columbia as outdoor tourism is a significant source of revenue for the province as well as a significant pass time for those residing there [6, 5]. Specifically, the pressures on high elevation biomes in the region have received increased attention with recent and ongoing proposals to expand helibiking (mountain biking involving helicopter access) throughout the region [4]. This means not only an increase in access to these areas but also an increase in a very particular user base. Current helibiking locations provide an opportunity to study the impacts of this user base on the ecosystems that will receive the increased use.

Within the region, existing trail infrastructure in the subalpine and alpine is primarily established and used by hikers, with equestrian users playing a varying role. The current interest centers around the relative impacts between hiking and biking users and their ecological effect on the communities they travel through. For this study, plant communities were used as the impacts are more easily isolated and have been well documented in various contexts.

With this in mind, this study was designed to evaluate several impact factors. Previous studies have demonstrated edge effects of trails both in the alpine (see for example 7, 8, 9) and along forested trails (see for example 10, 11, 12). The transition between these zones, however, remains less studied. One of the questions this study seeks to answer was whether or not the character of the edge impacts of a trail change as a function of its position relative to timberline; essentially, whether or not the number of trees impact the edge effects of a trail. The intention with this measure is to determine the importance of expansion of biking activity to higher elevations within the region with the hypothesis that impacts, from both hiking and biking, would be greater at higher elevations where plant communities are generally more sensitive to disturbance [13, 14]. The second main question that this study poses is whether or not the magnitude or character of impact differs between hiking and biking. This corresponded to the hypothesis that biking would have a larger impact than hiking, particularly in close proximity to the trail. These hypotheses were tested with a distribution of sites across latitudes and between the two different use types to allow the results to address a number of the relationships impacted by use in the Sea to Sky and give a context for inference to other locations.

Methodology

With these effects in mind, a methodology was designed to be both time effective and sensitive. Based on a number of previous studies [11, 15, 16, 17], quadrats were placed at the center and edge of the trail, as well as 2m and 4m from the edge (Figure 1). For each transect a coin flip was used, when terrain allowed, to determine which side of the trail the transect would run to [15]. Additionally, trail bearing (upslope), trail width, trail depth, elevation, trail slope, transect slope, and GPS coordinates were all taken at the trail for each transect.
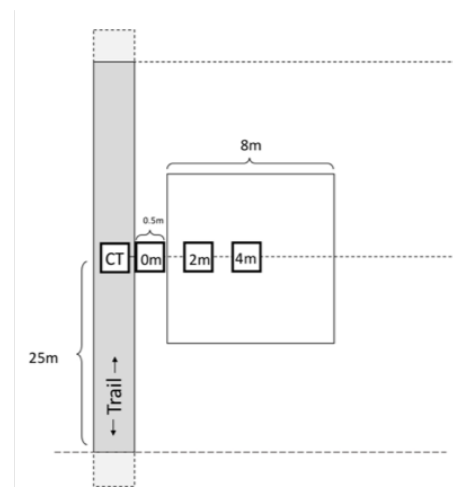

Figure 1: A diagram illustrating the field protocol applied for each transect.

Within each quadrat percent vegetative cover was surveyed. This cover was divided taxonomically (graminoids, forbs, shrubs, non vascular, and lichens) as previous studies have demonstrated varying impacts between these groupings (17. Price, 1985). Cover surveys were also divided into two height classes (<30cm and >30cm) to account for height tiers and canopy redundancy for each taxonomic group [18]. Cover of bare, exposed ground was also included. Cover was measured using a class based system supported by Hatton, West, & Johnson, 1986 [19] and Peet, Wentworth, & White, 1998 [20]. Richness and species composition was also documented for each quadrat. Some species were not differentiated within genus or larger grouping due to restrictions on identification resources and time.
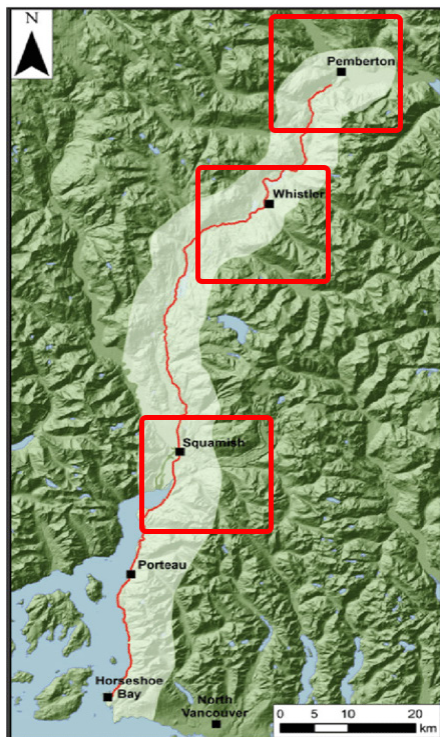

Figure 2: A map showing the Sea to Sky region with main towns labelled. Each red square marked corresponds with the area of a pair of trails used within the study.

In order to be able to quantify tree effects at each site an additional quadrat was used, this time 8 meters by 8 meters. The quadrat was centered around the corresponding transect with a half meter buffer between it and the trail to avoid trail overlap on curving sections. Trees above 3 meters in height were counted separately from those below 3 meters [21]. If trees above 3 meters were present then the diameter at breast-height (DBH) of the largest was measured, otherwise the height of the tallest tree was recorded.

For this study, six sites were selected within the Sea to Sky region. These sites were grouped into three sets of two, with a set each in proximity to Squamish, Whistler, and Pemberton (Figure 2). For each of these sets there was a hiking trail and a mountain biking/multiuse trail used. Each of these sites involved an array of 16 transects with 4 quadrats on each transect. Between the six sites used in the study this is a total of 384 quadrats.

Preliminary Results

Early visualizations of the data collected support the edge effects expected on plants surrounding trails. This includes taxon specific effects based on relative ability to tolerate trailside habitat. We see for example that graminoids seem to have their highest richness on average at the trail's edge, whereas other taxa increase consistently with distance from trail (Figure 3).
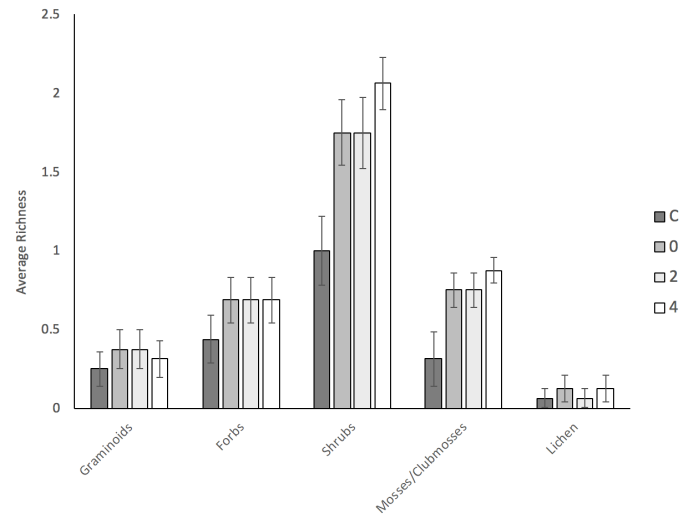

Figure 3: Average richness by quadrat position for the Gondola site in Squamish. Divided into taxonomic groupings.

Visualizations of use data also show potential differences between the impact of hiking and biking. Graminoids once again illustrate a potential difference, with percent vegetative cover in this taxon differing significantly in on-trail quadrats (Figure 4). The absolute significance and actual nature of differences remain to be determined with more rigorous analysis.
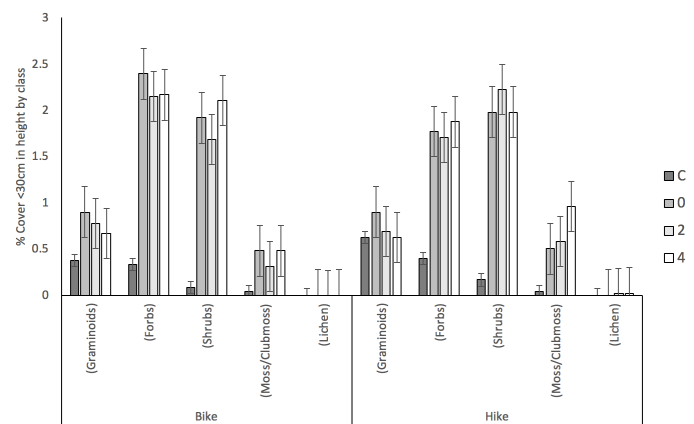

Figure 4: Percent cover per quadrat position averaged across uses by taxa. Note that percent cover measurements were taken according to a class system to reduce observer error.

Next Steps

Further analysis will seek to clarify and answer questions such as: "Do hiking and biking have the same effect on plant communities?", "Does tree density change trail effects on

ground cover species?", and "How do trails affect species composition?". As use of backcountry areas evolves and expands it will be increasingly important to understand the interactions between recreational uses and the communities they impact. Defining differences and/or similarities between mountain biking and hiking will help managers and scientists make informed decisions and statements about the importance of each of these activities to plant communities that perhaps have not seen them before or are newly experiencing the full brunt of their impacts.

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Challenges and opportunities for ecological restoration and inclusive governance in the renegotiation of the Columbia River Treaty

Graeme Lee Rowlands

As large as France, the Columbia River Basin is one of the greatest watersheds in North America. The main stem of the Columbia River is over 2,000 kilometers long and its largest tributary, the Snake, flows for another 1,735 kilometres above their confluence. When Canada and the U.S. agreed to draw the international border along the 49th parallel in 1846, they split the watershed in two. As a result, the basin today covers portions of British Columbia and seven U.S. States (most substantially Oregon, Washington, Idaho, and Montana).

The partition of the watershed has left many lasting consequences including the creation of the Columbia River Treaty (CRT). The CRT was designed to coordinate management of Columbia River flows using dams on both sides of the border to maximize collective hydropower generation and flood control across the watershed. The core of the Treaty involved Canada building three large dams in its portion of the basin and using them to produce cross border flows which prevent floods downstream and are ideal for hydropower generation at American dams. In return, the U.S. paid Canada $69.6 million CAD in advance for the first sixty years of flood protection and continues to give Canada half of the additional hydroelectricity it generates at its own dams as a result of treaty operations (presently worth approximately $120 million CAD per year). With almost no involvement of local people or Indigenous nations, the CRT was ratified in 1964 and most of its terms were fixed for 60 years. With the sixty-year anniversary approaching, Canada and the U.S. began renegotiating the treaty in May 2018.

While it is commonly celebrated as a model for international water governance, the CRT has inflicted many costs alongside its benefits. The Columbia River Basin once hosted the world's largest salmon run, with as many as 16 million fish migrating from the ocean every year. This renewable resource nourished ecosystems and indigenous people throughout the watershed both physically and spiritually for millennia. But, in tandem with other river development (such as extreme overfishing by early settlers, industrial water pollution, and the watershed's 46 major dams), the CRT has contributed to a devastating decline in salmon populations. Today, despite billions of dollars invested in recovery efforts, populations have stagnated at around 1.5 million per year, are blocked from more than half of their historic habitat, and are heavily reliant on fish hatcheries and other means of human support.

However, at this moment in history, there is a promising opportunity to restore salmon to the upper portion of the basin where they have been sorely missed for nearly a century. This is partially due to recent advances in fish passage technology but also owes much to the political opportunity presented by the renegotiation of the CRT. Among other possibilities for change, the new treaty could include a plan to pursue a collaborative international restoration program that would seek to return salmon all the way up the Columbia River towards its Canadian headwaters.

However, it is far from assured that the U.S. and Canada will choose to do this, as there are many other competing interests in the treaty. Additionally, shortly after negotiations began in May, the U.S. and Canada announced that they would exclude the basin's Indigenous nations from the negotiation, despite their deep involvement in the processes leading up to it.

This decision signals a move away from, rather than towards, inclusive governance. And, as I argue in an Op-Ed published in newspapers across Canada [1], it is also a move away from prioritizing salmon and ecosystems because the Indigenous nations of the basin are by far the environment's greatest champions.

Research that I published in the journal Water International with former Quest tutor Dr. Rich Wildman helps explain why this happened [2]. Recognizing that the prospects for salmon restoration are uncertain, the central aim of our study was to investigate which factors in the negotiation would be most significant for determining these prospects. Ultimately, we settled on six main factors but I'll discuss just two of them here.

In some watersheds across the world, decisions are made by basin commissions that are structured to represent a variety of perspectives. However, the Columbia River Basin has no such structure, which means that decision-making authority defaults to the Canadian and American federal governments, leaving no guaranteed place for Indigenous nations.

Our research also emphasizes that negotiating autonomy is an important asset in a process like the CRT renegotiation. If a negotiating team can act quickly and decisively without having to continually build consensus, it generally can negotiate more effectively. This is the major reason that the U.S. and Canada have chosen to exclude Indigenous nations from the process.

This is a strategic move on their part. But it raises a question that is at the heart of current struggles between Indigenous nations and settler governments in the Columbia River Basin and beyond. Do settler governments have a duty to actually involve Indigenous nations in decision-making processes? Or is it enough to simply consult with them on the side? The Indigenous leaders that I've interacted with and read from argue strongly that their right to share decision-making authority in their ancestral territories will eventually be validated and that it will be to the great detriment of settler governments to delay this validation.

To conclude, I'd like to highlight some words from the chairpersons of the three First Nations that have been excluded from the negotiation by the Canadian government [3].

"This treaty process will only succeed if all Indigenous nations are sitting at the table, ensuring that our rights and values are reflected in a new treaty. A treaty that remembers that the Columbia River was once a vibrant ecosystem that sustained the life of our ancestors. A treaty that commits to restoring the river, so that it can sustain us all."

These words illustrate clearly that inclusive governance and ecological restoration go hand in hand, which is something that should matter to all of us.

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Watching People Throw Out Garbage:
Food Service Waste Management in Squamish, BC.

Samantha Leigh

Key Results

• All but three food service institutions in Squamish have less than 40% correct waste item disposals, with 19 of 29 institutions showing 0-20% of disposals as correct.

• This means that most institutions have high (>80%) waste stream contamination and are thus susceptible to high tip fees and fines under Squamish's Solid Waste Utility Bylaw, 2017.

• Service Type and Sign Quality are the key characteristics impacting waste contamination and customer disposal behaviour.

• If all institutions replaced Landfill waste streams with a Compost stream, 24 of 29 institutions would exceed 60% correct disposals (<40% waste stream contamination), with 14 institutions above 80% correct disposals (<20% contamination).

• Thus, food service institutions in Squamish should prioritize implementing a Compost stream to decrease contamination and avoid high tip fees and fines.

Summary

     In May-July 2018, a total of 29 food service institutions in Squamish were observed to determine how the waste station set-up affects waste stream contamination. In this study, customers at each institution were observed disposing their waste. Items and the waste stream they were disposed in were recorded, with the disposal choice identified as either "correct" or "incorrect" based on waste stream standards in Squamish. In addition, characteristics about each institution's waste disposal station were identified and recorded to provide a qualitative assessment. Disposal behaviours such as "grouped disposals" of waste items, and repeat disposals by a single customer were also recorded for further analysis.

Waste Station Characteristics

     The characteristics of the institutions' waste systems were statistically modeled with contamination and customer disposal behaviours. The analysis showed that the two most important characteristics affecting contamination and customer disposal behaviour were the "Service Type" of the institution, and the "Sign Quality" provided at the waste station. First, "Service Type" describes whether customers typically disposed of meal waste, such as at restaurants, or drink service items like at cafés. Thus, institutions must ensure their waste systems are designed to accommodate their specific types of items as well as disposal behaviours common in their institution. Second, "Sign Quality" describes varying levels of effective signs posted at the waste station. Typically, waste disposal stations with signs had lower contamination. However, few institutions had signs, and those which did also had multiple streams whereas institutions without signs typically also had only one stream. Since "Sign Quality" and "Number of Streams" also covary, institutions should implement multiple streams and effective signage in tandem to ensure decreased contamination.

Composting Importance

     An additional analysis substituted all Landfill waste disposals with a Compost disposal. This substitution simulates expected contamination if all food service institutions were to replace their Landfill stream with a Compost stream, without changing any other characteristics of their waste system. Such an intervention addresses the fact that most waste products generated at food service institutions are food waste or paper-based products such as wrappers or napkins, which should be composted (not recycled) when contaminated with food products. In addition, many food service institutions provide certified compostable plastic products, which are accepted in Squamish's commercial composting stream. Observed contamination levels were high, where all but three institutions in Squamish have less than 40% correct waste item disposals, with 19 of 29 institutions within 0-20% correct disposals (Figure 1). By substituting all Landfill disposals with a Compost stream, 24 of 29 institutions would exceed 60% correct disposals (<40% waste stream contamination), with 14 institutions above 80% correct disposals (<20% contamination) (Figure 2). Since Squamish's Solid Waste Utility Bylaw, 2017 [1] requires all waste streams to contain less than 20% contamination, food service institutions should prioritize implementing an effective composting system to reduce Landfill contamination.

Observation Methodology Applicability

The observation methodology used in this study is cost-effective and can be reused by food service institution managers to further improve their waste management systems, without requiring a comprehensive waste audit. Waste audit standards and waste management facilities typically quantify contamination by weight [2, 3]. In addition, the District of Squamish and its waste contractor collect quick audit data by visually assessing waste to approximate contamination [4]. As such, this methodology of quantifying contamination based on item disposal likely provides a finer-scale resolution of waste contamination, so that if institutions strive to obtain less than 20% contamination by item disposal, they are likely to achieve or surpass contamination requirements by other metrics. Therefore, institutions should use this methodology of observing and recording customer disposals because it is more cost-effective and less messy than a comprehensive waste audit yet will allow them to make plans to achieve waste diversion and maximum contamination requirements.

General Recommendations

In general, all food service institutions should implement a Compost waste stream and provide signs for their customers. Providing multiple streams and clear signage encourages customers to sort their waste, allowing the institution to divert more waste from landfill. In addition, it is important for food service institutions to ensure their waste streams do not exceed 20% contamination to comply with the Solid Waste Utility Bylaw, 2017. To reduce Landfill contamination, institutions should begin by implementing an effective Compost stream to catch all food waste and paper products. Combined with effective signage, institutions could rapidly achieve minimum contamination requirements. Moreover, streamlining products so that all waste items are made from certified compostable plastics (BPI, ASTM-6400) would allow food service institutions to provide only one or two waste streams, thus making disposal choices simpler for customers and more convenient for institutions to sort and manage.
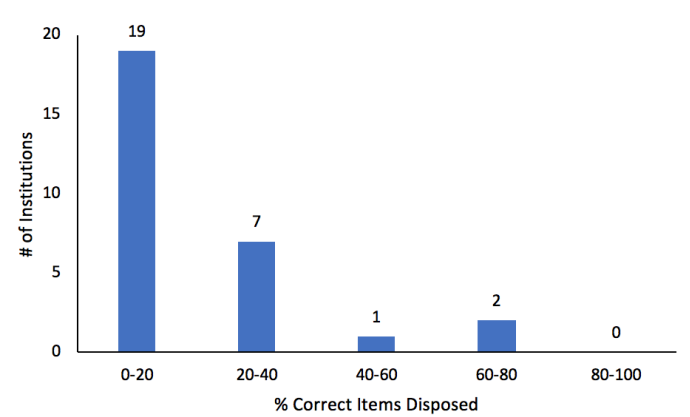
Key Figures

Figure 1: Percent Correct Items Disposed at all institutions (n=29). Most institutions have 0-20% correct item disposals, which is not sufficient to meet DOS Solid Waste Utility Bylaw, 2017, stipulations requiring <20% contamination (i.e. >80% correct disposals) (1. District of Squamish, 2017).
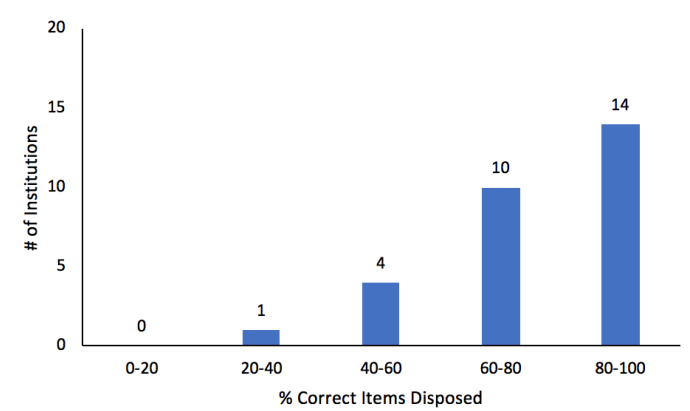

Figure 2: % Correct Items Disposed at all institutions (n=29) if all Landfill disposals had been into a Compost stream instead. (Compare to Figure 1). If each institution were to provide a Compost stream instead of their current Landfill streams, many more institutions (n=14) meet DOS bylaw requirement <20% contamination, since they would have >80% correct choices (1. District of Squamish, 2017).

References

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