Can one size fit one? A prospect for humane custom production

Abstract
In this article, I advance two complimentary arguments. My first argument is methodological. I contend that, in order to understand new technologies and practices in a nuanced way, attending to past analogs is crucial. I support this methodological argument by comparing a historical form of custom production (18th and 19th century dressmaking) against currently dominant practices of mass-customization (flexible mass production customized through online interfaces). A second argument stems from the first: supported by the comparison of a historical and a current mode of custom production, I argue that current modes of mass-customization do not do justice to the potential of custom production. I lay out a set of criteria for doing humane customization and suggest that small-scale production has a better chance of successfully centering the user than does production at larger scales. As such, there is room for those involved in shared machine shops to embody a more nuanced practice of digitally-aided custom production.

1. Understanding mass-customization by studying dressmakers

This article spans roughly two-hundred years. It starts with dressmakers in Europe and North America, in the century leading up to the widespread adoption of mass-production in the garment industry, moves through current modes of mass-customization, and ends with a hope for the future of custom production in and with shared machine shops. While it may seem counter-intuitive in a special issue on shared machine shops to discuss pre- and early-Industrial custom dressmakers, they represent a past which is frequently invoked in current discourse about digitally-aided custom production and customization of consumer goods. This article is, in essence, about different structures of custom production of goods, and how those who inhabit shared machine shops can productively intervene in evolving practices of digitally-aided custom production. Because various kinds of shared machine shops—makerspaces, hackerspaces, and other collective sites of fabrication—offer access to desktop digital manufacturing tools and are sites of experimentation and expertise-sharing, they represent an ideal locale for small-scale explorations in the utility of digital fabrication for custom production.

The structure of this article is as follows: Historical modes of production are frequently leveraged in arguments about the current and future state of manufacturing. Advocates of new technologies use history as a justification for the significance of the technologies they are promoting. This is especially evident if there is a suggestion that a new technology will bring in a major change. For example, a number of recent developments in digital fabrication technology (especially anything that can be placed under the umbrella of 3D printing) are promoted in the context of past industrial revolutions, in order to bolster the claim that these new technologies will be equally paradigm-changing. 3D printing has been particularly linked with the idea of decentralized, small-scale manufacturing, which in conjunction with the idea of the circular economy is positioned as an opportunity to intervene in the current paradigm of globalized manufacturing and consumption (eg: Lipson and Kurman, 2013). A problem with these kinds of claims is that, in order to set up a tidy case for the importance of a new technology, history is collapsed and over-simplified. This appears to be especially prevalent in the use of the 18th and 19th century industrial revolutions as events which are seen as similar to changes happening in manufacturing now. Of particular interest in the context of this article is how descriptions of digital fabrication technologies often come along with ideas about how they will make mass-customization (and thus, the ownership of custom-made goods) more viable and widespread. The subtext of such claims is that customization, on a non-mass basis, has been almost entirely eliminated by the advent of mass-production at the end of the 19th century. Thus, the methodological claim I advance in this article is that those who want to develop more nuanced views of new technologies can do so by

attending carefully to the history and context behind the arguments used to promote the utility of those new technologies. Looking at the broader context of the histories leveraged offers the opportunity to gain a more nuanced understanding of how we might better accomplish the things we seek to do with new technologies, or even how to better evaluate the claims of others about the capabilities of said new technologies. I do that by comparing the practices of 18th and 19th century custom dressmakers against current systems of mass-customization. Drawing on the comparison of those examples, I argue that there are criteria we should attempt to embrace in order to do humane custom production which centres the needs of the potential user[1][1]. Such humane custom production, I suggest, is better done at small scales than large ones, providing an opportunity for those active in shared machine shops to develop sensitive and humanistic modes of custom production, different from the currently available modes of digitally-aided mass-customization.

It's a commonly-repeated truism that those who forget the past are doomed to repeat it. This implies that the past is undesirable, something we would not want to repeat. However, we do frequently remember the past with nostalgia, appreciating the things that we believe to be better than the analogs we have now. The risk in such a use of the past is not forgetting it wholesale, but failing to acknowledge and use the portions that may go against our preconceptions and desires. In this article, I use history as a tool for informing the future. In particular, I argue that apparently abstract traits we value from the past, like attention to detail, fitness for purpose, and care, should be seen within the context of broader ecosystems which we often forget or erase. I use the case of custom dressmakers in portions of 18th and 19th century England, France, and North America to understand, illuminate, and provide contrast for current and emerging practices of digitally-aided mass-customization.

Digitally-aided mass-customization, by its very definition, bears a resemblance to mass production. However, digitally-aided custom production, absent the logic of "mass" is something which pervades makerspaces, hackerspaces, and other fabrication spaces. The desire to make something that suits one's purpose is well-represented in the shared machine shops that are the subject of this special issue. Participants in shared machine shops carry out individual tinkering and making tasks for themselves, as well as potentially producing items for broader use, both inside and outside the shared machine shop (Jensen et al, 2016). While the nature of the goods produced varies from person to person and from shop to shop (eg: the examples of projects covered in Niaros, Kostakis, & Drechsler, 2017), the shared act of building an object is one which can be (and is) harnessed in service of custom production of consumer goods. The principle of scratching one's own itch which comes from Free/Libre and Open Source Software and persists in many shared machine shops is an entry point for thinking about how one might tailor a self-made object to one's own needs. Another F/LOSS trait, decentralization of labour, is also frequently cited as a factor in shared machine shops, allowing participants in one venue to make use of the efforts of those located elsewhere (Kostakis et al, 2015), which offers opportunities for the production of customized goods based on pre-existing template objects.

It is important at this point to note a distinction between customization and custom production. I take customization to imply the ability to make modifications to a template object, while custom production implies a good produced from scratch, absent the template. Custom production is tied up in the story of pre-Industrial production, just as mass-customization owes its existence to mass production. In drawing such distinctions, I do not wish to advance the idea that the pre-Industrial era was some kind of golden age during which craft producers perfectly attended to all of the needs of their clients. Rather, I acknowledge the popular fallacy of conflating the current state of digital fabrication with an idealized conception of artisanal production (Morozov, 2014 further troubles the similarities between Makerism and the American version of the Arts and

Crafts movement). While a flat view of industrialization is often presented in support of rhetoric about a new industrial revolution, there is significant scholarship backing up the idea that industrialization was complex, messy, and unevenly distributed, with craft practices and industrial methods coexisting for some time (Blaszczyk, 1995; Sabel & Zeitlin, 1985). Instead, I wish to point out that custom production, co-existing with industrial methods, embodies a co-creative and complex relationship between a producer and a consumer. I use the example of dressmakers to describe a mode of custom production which provides a number of points at which the end user is invited or expected to participate in the production process.

I contrast the case of the dressmakers against current modes of digitally-aided custom production in order to support a methodological argument. I contend that, in order to understand new technologies and practices in a nuanced way, attending to past analogs is crucial. My second argument stems from the first: supported by the comparison of a historical and a current mode of custom production, I argue that current modes of mass-customization do not do justice to the potential of custom production, and that there is room for those involved in shared machine shops to embody a more nuanced practice of digitally-aided custom production. I use the word "humane" in this context to describe a kind of relation between consumer and producer which embodies care and consideration for the individual, traits which are not generally associated with industrial systems of production.

2. The problem with parametric customization

There are two terms at issue in this section. Though the terms themselves differ, they describe similar processes. The first is mass customization, a term which, as it is most frequently deployed, describes the idea that a customized good can be made on a mass scale. Mass customization generally entails the use of digital fabrication technologies in a flexible mass production context, which is to say that a manufacturing facility is configured in such a way that the nature of the goods produced can be changed without necessitating a complete refit of the factory (Blaszczyk, 1995). Zipkin (2001) suggests that mass-customization has three basic traits: a means of eliciting requirements from the customer, a production process flexible enough to produce one-off variations of goods, and a system of logistics capable of tracking and delivering goods on an individual level. The second term, parametric customization, follows on from the need to elicit user preferences and make a flexible production system feasible within the confines of a mass-production environment. Parametric customization is how most current mass-customization is done. It is a process by which a consumer uses a parameterized system (often in the form of a website) to customize a few variables in a product which is then produced through a wholly or partially automated process. By parameterized, I mean to say that a few specified elements of the good being customized are capable of being manipulated. In a garment, for example, a user might be able to specify custom values for particular measurements (eg: inseam, chest circumference, etc.), what kind of fabric is to be used (from a set selection of fabrics), or the style of a particular element (different kinds of cuffs on a shirt, for example). All of these parameters are built into both the system by which the user customizes their good—often referred to in the literature as configurators (Aichner & Coletti, 2013)—and are accounted for in, or even constrained by the mode of production.

While it is not necessarily the case that all mass-customized goods are produced using parametric customization and online configurators, at the moment, many are. Possibly in order to fit into existing industrial processes, popular mass-customized products (shoes, garments, computers, furniture, etc.) offer users configurator systems through which components, materials, measurements, and combinations can be modified or swapped. The modifiable parameters, and the extent to which they can be manipulated, vary from system to system and from product to product. For example, NIKEiD, which allows the parametric customization of various athletic shoes, has

differing materials, colours, and themes available from shoe model to shoe model. Some of these are sold as functional options (such as the Flyknit range, which promises technical benefits [Etherington, 2012]), while others are more explicitly aesthetic (such as one shoe which offers a seemingly deliberately small range of available colour choices for its configurable elements).

Though a custom product can indeed be something which is uniquely made for an individual, most products and systems articulated in the logic of mass customization rely on many of the same assumptions as mass production. Most important of these assumptions is that there is no meaningful change in the process of production or requirement-gathering. In part, this is for practical reasons: the "mass" in "mass-customization" is not feasible if new design work or new modes of conveying user requirements and preferences must be devised or specified every time a template good is customized. There is an opportunity in customization for the user to put their own mark on a good. However, when opportunities for intervention are curtailed or over-structured both by the system through which input is collected, and by the mode through which the good is built, the potential value of the user's intervention diminishes somewhat. I indicated briefly in the previous section that the term "customization" implies a distinction from custom production: something is being customized, modified from a standard or generic form to become more appropriate for a given user. This could be thought of as distinct from custom production, a term which implies that a good is being made, from scratch, to respond to the requirements or specifications of a given (and known) user. Marsh (2012) offers definitions of what he calls mass customization and mass personalization. Mass customization, he suggests, is a process by which modular options are chosen by a consumer in order to customize a previously standard good. Mass personalization, he suggests, is the act of producing a totally unique custom good for a customer. Marsh's mass customization is a kind of mass production, but with modular parts which can be swapped in order to make a good more individual.

Who gains value from a custom or customized good is also at issue. Zwick, Bonsu and Darmody (2008) suggest that the benefit for producers in mass customization comes from a potential increase in customer retention and satisfaction. But does that satisfaction extend to broader benefits for the purchaser of a custom good? Some existing literature on consumption argues that agency is an important facet in one's relationship with an object. The ability to modify or put one's own mark onto a good, so the argument goes, mitigates some of the alienation that comes from having little or no stake in the industrial process that made the good. Campbell (2005) charts a move in the conception of consumers from "dupes, conned into buying quantities of aesthetically uninspiring standardized products, many of which they did not actually need and few of which were capable of bringing any real or lasting satisfaction" to critical, resistant, and self-aware consumers engaged in building identities through engagements with products (p. 26). Campbell goes on to advance the idea of the craft consumer, "someone who transforms 'commodities' into personalized (or, one might say, 'humanized') objects" (2005, p.28). Watson and Shove (2008) argue this this idea of the humanization of objects through personal labour is consistent with ideas of craft production advanced by Marx and Veblen.

From a very different perspective, work in marketing and consumer behaviour suggests that having a stake in the design or assembly of a good can increase an individual's subjective valuation of the good (Dahl & Moreau, 2007; Moreau, 2011; Franke, Kaiser, & Schreier, 2010). This has been dubbed the "IKEA effect" by Norton, Mochon, and Ariely (2011). The idea that an individual can have a stronger affective relationship with a good is often leveraged to gain profit. Stories in the history of marketing and product development are circulated as reminders that there is a sweet spot between effort and potential failure. We are famously reminded of the early days of Betty Crocker cake mix, which rendered a cake too easy to make, supposedly causing those baking it to find the act/product unsatisfying, and too unlike the process of cake baking they were used to. In the story, the problem is solved by taking the egg powder out of the mix, instead asking the user

to add an egg themself (this story is told in many places, one of which is Norman, 2010). The story can be seen in two ways. It is frequently taken as an example of a marketer finding a sweet spot at which a consumer can experience a desirable combination of satisfaction and convenience, which will cause them to feel pleased and accomplished, and thus buy the mix again—a tactic which seems to have worked, given the continued existence of Betty Crocker cake mix. Norman (2010) describes it as a kind of passive instruction-following, rather than a real creative act. Beyond the judgment of whether or not following instructions for baking a cake counts as a creative act, the story can be viewed as an example of the manipulation of affect for the purposes of profit. By contributing some additional labour and materials to the production of the cake, the user of the mix feels more positively towards the outcome of the process.

Even when one is supposedly co-creating a product by contributing labour, materials, or ideas, the user/consumer is all too frequently seen as separate from the process of production. The addition of user labour, in cases like the cake mix or a customized running shoe is not about creating an efficiency for the producer. While the rationale behind an IKEA flat pack might well be a saving in production and shipping which is then passed on to the consumer—along with the need for assembly—other experiences are designed to use labour to generate an affective tie. When you have chosen the colour of each portion of your new running shoes, they feel as if they are more *your* shoes than they might otherwise be. The contribution of labour, though it is a negligible addition to the process of production, adds value to the product in the eyes of its purchaser.

3. Dressmakers as pre-Industrial/early-Industrial custom production

Current practices of mass-customization are rooted in flexible mass-production processes and parametric customization. These processes differ starkly from many forms of pre- and even early-Industrial custom production. In this section, I look at a historical case: dressmakers. I use the word "dressmakers" to refer to (predominantly) women in (mostly) urban centres of the United States, England, and France during the 18th and 19th centuries who worked in a subset of the garment trade. While working methods were not entirely homogeneous between all of the cities and times encompassed in that range, they were similar in broad strokes, differing in specifics like whether or not a given dressmaker belonged to an incorporated guild, her proximity to centres of fashion, and whether or not she had clients who required court dress (a requirement in 18th century Paris, for example, but not 19th century Boston). Common to all the dressmakers, however, is that they were engaged in a practice of custom production.

Dressmakers in the 18th and 19th centuries produced custom-made garments for known clients. Custom production of garments was a widespread and dominant practice. This is not to say that no mass-produced clothing existed at the time, but pre-made garments were neither of high quality nor of great desirability (Rogers, 1997). Those who could afford to employ a dressmaker, did. Many of the women who could not afford to employ a dressmaker (or could for some garments, but not an entire wardrobe) sewed their own garments, and indeed produced garments for their families. In the earlier part of the period, commercial sewing patterns did not yet exist, meaning that if women chose to make their own clothing, they would be dependent on existing clothing in fashioning a pattern for a new garment (Hafner-Laney, 2010). Dressmakers, as a profession, held the knowledge of how to draft a pattern—a task which would often be carried out on the client's body, sometimes with light fabric which would eventually become the garment's lining, as well as a pattern for the exterior portions of the garment (Crowston, 2001). Similarly, sewing machines were not introduced until comparatively late in the 19th century (Schorman, 1996), meaning that tedious tasks like the stitching of the hem on a skirt were carried out by hand.

Dressmakers worked in consultation with their clients. Customers of dressmakers would be invested in the design of their garments, providing guidance on what they wanted, at multiple stages during the process of production. In addition to providing both an initial idea and ongoing feedback,

the customer was also in charge of providing the fabric from which the garment would be made. Fabric was an expensive commodity, and the businesses of dressmakers were generally small, with little scope for speculatively carrying large amounts of costly materials (Gamber, 1992). The cost of the components of a dress would equal or exceed the cost of the labour put in by the dressmaker and her employees (Hafner-Laney, 2010). The customer would be responsible for sourcing the materials she wished her garment to be made from, which would be fashioned in the dressmaker's workshop. A dressmaker on a smaller scale might well have had no permanent employees and indeed even a mistress with employees was very likely to use her own home as a workshop, doing her fittings in the home of the client (Crowston, 2001). There is historical evidence to support the idea that, in small towns in the United States, some dressmakers split labour with their clients, with clients paying for the specialized labour while doing the tedious but less-skilled plain stitching themselves (Fernandez, 1994).

In regions in which a system of indenture existed, the mistress dressmaker, proprietor of an establishment, would be paid a fee to receive an apprentice (paid for by the apprentice's family, a charitable institution, or some other benefactor), who she would then be responsible for training and housing over the course of several years (Rogers, 1997; Ginsburg, 1972). Apprentices carried out the least skilled tasks in an establishment (such as sewing the hems of skirts), while progressively more skilled workers would carry out commensurately-skilled tasks. In some workshops, the least skilled tasks might be outsourced to women who sewed in their own homes, for piecework rates (ibid). The outsourcing of plain sewing in such a case would allow the workers in the dressmaker's shop to focus on the parts of the task that required a higher level of skill. Cutting would be done by the mistress of the establishment or one of her more senior employees, as it was both an opportunity for costly mistakes (a wrong cut could ruin an expensive piece of fabric provided by the client) and the instantiation of the most prized skill in the workshop: the drafting of the pattern. For this reason, fittings were also carried out by the mistress or a high-ranking member of her staff (Crowston, 2001; Ginsburg, 1972). The system was not perfect, of course. For example, working conditions in the 19th century London garment trade were poor (Rogers, 1997) and the vast majority of 18th century Parisian apprentices never became mistress dressmakers (Crowston, 2001). And, being a profession of women at a time when women were not generally seen as equal in business, dressmakers could be at a structural disadvantage compared to their male counterparts in the draping and tailoring trades (Rogers, 1997; Ginsburg, 1972).

Towards the end of the 19th century, styles of dress in the British and American spheres of fashion influence changed, with a garment called a “waist”—a kind of blouse—becoming increasingly popular. The move away from tailored suits and dresses, and towards waists and skirts has been seen as a contributor to the growth of mass production in garments for women (Gamber, 1992). Nancy Green (1994) has argued that a crucial move at the time was from production for a known customer to production for an abstract one. In the absence of a known customer, standard sizes and assortments began to stand in, in place of the individual and her particular requirements.

4. Dressmakers versus parametric customization

Comparing pre-/early-Industrial dressmakers to parametric mass-customization systems reveals three key areas of difference. Those differences are the existence of a known client, the structure of interaction between client and producer, and how parameters for customization are defined. In this section, I elaborate on those three areas.

The prime difference between parametric mass customization and pre-/early-industrial forms of customization is the existence or not of a known user. In parametric mass customization systems, the user is treated as a mass-user. In the previous section, I raised Green's argument that an important move in the industrialization of garment manufacture was from the idea that a garment should be made for a specific, existing, real customer to the idea of a generic customer who does

not need to be present for the good to be made. In the kind of custom production enacted by the dressmakers, a customer is necessary for a garment to be called into existence. In mass production, a garment is made speculatively, to be purchased by a customer in general rather than a specific customer. The contrast between a known customer and an unknown one also holds in parametric mass-customization. While the dressmaker has a specific customer in mind, the designer of the system through which mass-customization is done not only does not draw a one-to-one relationship between the good and its purchaser/user, but must assume some notional user, albeit one with slightly different tastes from another notional user. While an individual customer may well have the power to make modifications which render the garment more useful or better fitting, they are simply another user of the system. The system itself does not change to accommodate the user. In the context of a shared machine shop, individuals frequently build things for themselves. The Do-It-Yourself practices embedded in makerspaces and hackerspaces not only offer opportunities for individuals to make for themselves, but to share ideas, skills, and best practices with others participating in the shared context (Rosner & Fox, 2016; van Holm, 2017; Schmidt & Brinks, 2017). While shared fabrication spaces are often viewed as potential sources of innovation (van Holm, 2017; Lindtner, 2017), there is the potential for commercial engagement on a more modest scale: extending the existing DIY activities to encompass custom production for others. While I am not arguing that all shared machine shops should be aiming to spin off or host businesses, there is certainly the potential and the infrastructure for individuals in such spaces to be making goods, on a custom basis, for others. This leads to the second difference: how interaction in custom production is structured.

Parametric mass-customization systems that rely on configurators offer a very narrow range of opportunities for the user to intervene in the design of the good being customized. During the customization process, it is impossible to break out of the script provided by the producer. From a practical perspective, this does make sense if production will be carried out through a standardized process, as is often the case in mass-customization. But, as with the dressmakers, it does not need to be the case when smaller numbers of goods are being produced. For the dressmakers, the process of design takes place in consultation with the user, who is capable of asking for modifications to not just specific measurements and elements, but to the whole garment. Such an in-depth consultation seems far less feasible when the interaction is constrained by a fixed interface. However, the use in shared machine shops of general purpose tools like 3D printers and laser cutters offers an opportunity not currently open to many mass-customization systems: the chance to make goods unconstrained by a specific industrial process. While the output of a given machine is of course bounded by the materials it is capable of using and by other exigencies, the one-to-one relationship highlighted in the previous paragraph offers an opportunity for a motivated producer to work creatively within the given boundaries, to the benefit of the end user.

Constrained interaction leads to the third element: when an interaction is structured solely by an interface which cannot be changed by the user, the range of parameters to be customized is also fixed. This differs from more traditional modes of custom production in which the selection of modifiable parameters is only limited by the construction requirements of the garment, the budget of the user, and the skills of the dressmaker. When I use a web-based configurator to customize a pair of Nike shoes, I am offered a constrained set of options which cannot be expanded. I am allowed to make choices about the colours and materials of certain elements of the shoe, but cannot, for example, choose a different kind of insole or different amount of padding on the tongue of the shoe. The design of the configurator restricts the user to the customization of a curtailed set of elements. This is an important problem when an edge case presents itself. If a user's requirements fall outside of the range of what is considered normal practice, a system of parametric customization bounded by a prescriptive configurator will not allow enough leeway for the user to have their needs met. For example, some activities which might be undertaken while wearing a garment wear more heavily on the fabric of the garment than “normal” usage. Cycling, gardening,

or using an assistive device (like a brace or prosthesis, for example) might all cause wear on a pair of trousers. A tailor might choose to line the garment, or build in an additional layer of fabric in a certain spot in order to account for the anticipated wear. Such an option is unusual enough that it is unlikely to make an appearance in a generalist parametric customization routine, and would instead need to be undertaken as an after-market modification. Von Hippel offers the idea of the "lead user" (2005), an individual who pushes the boundaries of product design in order to meet a niche personal requirement. Van Holm (2017) suggests that many shared machine shops are populated by lead users, who, after meeting their own needs, may go on to commercialize their solutions. One hopes that such commercialization, coming from a recognition of non-standard needs, might build in a degree of attentiveness and care for the end-user.

The three items above are areas where modes and methods differ between how traditional forms of custom production have been carried out and how current systems of parametric mass-customization structure use. In the next section, I take those three items and turn them into actionable criteria for doing humane custom production and customization which is user-centric and carries over some of the valuable aspects of historical custom production As indicated above, some of those practices are already taking place in shared machine shops. In the following section, I provide a framing for the application of those existing practices in the service of humane custom production.

5. Criteria for doing humane customization and custom production

In the previous section, I outlined three areas in which current modes of parametric mass-customization differ processually from historical modes of custom production. I argue that, while the benefits of historical custom production are often ascribed to mass-customization, current modes of doing parametric mass-customization often do not provide many of the valuable benefits of older modes of custom production. Below, I build on the problems outlined in the previous section to suggest three ways in which we can do a more humane and user-centred job of customization and custom production of digitally-produced goods. The idea of "humaneness" I am advancing is not grounded in a particular discipline or literature, but is instead an everyday kind of attitude. To be humane, in its dictionary definition, is to be "characterized by sympathy with and consideration for others; feeling or showing compassion towards humans or animals; benevolent, kind" (Humane, 2009). I propose, as such, that to be humane is to be attentive to the needs and desires of another individual, and to exercise a degree of compassion. This orientation, I argue, is often eclipsed by the idea that a consumer has rational choice and the power to act on it. I propose that humane custom production puts some of the onus of care back onto the producer, and onto their partnership with the person for whom they are producing a good.

I argued above that what differentiates historic custom production from current forms of parametric mass customization are three factors: the existence of a known client, the absence of a constraining user interface, and the ability to modify or expand which parameters of a good are customizable. In order to do digitally-aided custom production and customization which carries over the best parts of the historical practice, we need to take on board the differences that currently exist between the two. I suggest that custom production which is humane and user-centric should be rooted in a real user, provide opportunities for interaction outside of a rigid interface, and offer flexibility in the range of parameters that can be modified. While I recognize that these criteria are not easy to implement on a large scale, that is perhaps what is most exciting about them.

The bulk of this article has been concerned with two modes of production: pre-/early-Industrial custom production and current modes of parametric mass-customization. I have offered some indications about how shared machine shops fit into the picture by providing spaces in which individuals and groups can and do think about how things are made. I now argue that the criteria I

have outlined for humane and user-centric custom production could be best carried out in the context of shared machine shops. I outline my rationale below.

Rooted in a real user

Small scales make it easier to actively involve the user in the process of production. It is difficult, in current systems of industrial manufacturing, to attend to the specific needs of an individual user, rather than to the needs of the existing system of production. Attending to the individual user is far more achievable at small scale. It is easier for an individual or organization with modest throughput to provide a service in which a user can be seen as an individual than it is for a larger organization with commensurately large-scale production to do the same. Certainly, as manufacturing becomes more flexible through the integration of general-purpose tools like 3D printers, the promise of custom production becomes more tangible. But, I argue, when the manufacturing itself becomes more flexible, the problem of humane customization comes to be downloaded onto the interface for designing the good. Even if a system of production with comparatively few constraints is available, in order to operate at a large scale, there must be some constraints in the process of design. Otherwise, users are simply left to upload CAD (computer-assisted design) files, which—given the amount of labour and specialized skill currently involved in producing them—is not an outcome with enormous popular appeal. An individual rooted in or with skills gained in a shared machine shop could ease such issues by taking on the role of intermediary, offering the design expertise necessary to produce a good, using some off-the-shelf 3D models, while working at an individual scale, attentive to the needs of the individual client.

Breaking out of the rigid interface

My second recommendation, that humane customization needs to allow and promote interactions that are not curtailed by the dictates of a static interface, equally lends itself to small scales. A routinized system of production and logistics can necessitate a constrained system of input. When the parameters for a good need to fit into a specific production framework, it makes practical sense for the system of input to map to the exigencies of the mode of manufacture. As such, small-scale efforts at production, which have a greater capacity for ad hoc solutions, offer opportunities for less rigid interfaces. In small-scale production, the producer has an unparallelled opportunity to elicit input and requirements from the user without the rigid constraints of something like a configurator. Indeed, one might consider doing taking a tip from the dressmakers and simply making the human the interface.

Flexible parameters

Following on from the idea that a less-rigid interface between the user and the producer is essential for humane custom production, I further contend that flexible parameters are also a key element differentiating what I am calling humane customization and custom production from currently-dominant forms of mass-customization. Flexible parameters make serving edge cases more feasible and are well-suited to smaller production millieux. Peter Marsh has argued that "[w]hen 3D printing techniques become an everyday part of manufacturing, mass personalization will truly have come of age" (2012, p. 61). I make the more general suggestion that the range of tools frequently used in shared machine shops to increase capacity and production skill (eg: a laser cutter or CNC mill offers the ability to do more complex woodworking than is feasible without) also offers the opportunity for producers situated in such locales to do forms of custom production which are not bounded by strict parameters dictated by existing industrial production processes.

6. Conclusion & areas for further work

In the previous section, I outlined three criteria for doing humane customization. More broadly, those three criteria can be encompassed in the idea that one way to leave room for discussion between users and producers is to leave some spaces where human intervention is necessary in order to complete a process. The act of intentionally leaving room for interaction and

intervention fulfills the criterion of being attentive to the needs of a specific user. And that is an area where shared machine shops can be of especial value, offering a space for the small-scale digitally-aided production of custom goods, as I indicate above. While I am by no means suggesting that the value of shared machine shops is in being places of business or incubators for spin-off enterprises, I do contend that they offer an opportunity to consider the place of human agency in the production of niche and specialized goods. Humane custom production and customization, I contend, should be about the augmentation of human skills and capacities in order to meet user needs.

In the bulk of this article, I have contended that digitally-aided customization and custom production should (and does already) take place in shared machine shops. Others have already documented at some length the kinds of user-centric production which take place in Hackerspaces, Makerspaces, and Fablabs. Toombs, Bardzell, and Bardzell (2014) have notably documented tool-making practices in a shared machine shop, a kind of making for onesself which is extremely attentive to a particular desired use. I argue that those resident in shared machine shops are well-placed to scratch not just their own metaphorical itches, but also the itches of others.

I have aimed in this article to use a historical example to shed additional light on how we might think about custom production. I suggest that historical analogs can be used to consider other issues relevant to the adoption of new technologies. In the case of custom production, the historical example of the dressmakers provides a litany of traits that can be used to evaluate the claims of current modes of mass-customization. While digitally-aided mass customization makes a grab for the terrain of "custom", the example of the dressmakers shows areas where mass-customization does not succeed in seizing that territory. Using historical analogs to evaluate current claims represents a way of finding what terrain is up for grabs, functionally and rhetorically.

[1] The word “user” appears with some prevalence in the latter portion of this article. I employ the word “user” in particular because it implies a degree of agency which “consumer” does not always carry, while also implying the use of a system, something which “client” does not do.

References

Aichner, T., & Coletti, P. (2013). Customers' online shopping preferences in mass customization. *Journal of Direct, Data and Digital Marketing Practice, 15*(1), 20-35. doi: http://dx.doi.org/10.1057/dddmp.2013.34

Blaszczyk, R. L. (1995). “Reign of the robots”: The Homer Laughlin China Company and flexible mass production. *Technology and Culture, 36,* 4, 863-911.

Campbell, C. (2005). The Craft consumer. *Journal of Consumer Culture, 5,* 1, 23-42.

Crowston, C. H. (2001). *Fabricating women: The seamstresses of Old Regime France, 1675-1791*. Durham, NC: Duke University Press.

Dahl, D. W., & Moreau, C. P. (2007). Thinking Inside the Box: Why Consumers Enjoy Constrained Creative Experiences. *Journal of Marketing Research, 44,* 3, 357-369.

Etherington, R. (2012). Flyknit running footwear by Nike. *Dezeen*. Retrieved from https://www.dezeen.com/2012/02/22/flyknit-running-footwear-by-nike/

Fernandez, N. P. (1994). Innovations for home dressmaking and the popularization of stylish dress. *Journal of American Culture, 17*(3), 23.

Franke, N., Kaiser, U., & Schreier, M. (2010). The "I designed it myself" effect in mass customization. *Management Science, 56,* 1, 125-140.

Gamber, W. (1992). A precarious independence: Milliners and dressmakers in Boston, 1860-1890. *Journal of Women's history, 1*(4).

Ginsburg, M. (January 01, 1972). The tailoring and dressmaking trades, 1700-1850.*Costume, 6.*

Gordon, S. A. (June 15, 2004). "Boundless Possibilities": Home Sewing and the Meanings of

Women's Domestic Work in the United States, 1890-1930. *Journal of Women's History, 16, 2, 68-91.*
Green, N. L. (1994). Art and Industry: The Language of Modernization in the Production of Fashion. *French Historical Studies, 18,* 3, 722-748.
Hafner-Laney, M. (2010). "I was tempted by a pretty coloured muslin": Jane Austen and the art of being fashionable. *Persuasions, 32.*
Humane (2009). in *Oxford English Dictionary*, (3rd ed.).
Jensen, M. B., Semb, C. C. S., Vindal, S., & Steinert, M. (2016). State of the art of makerspaces-Success criteria when designing makerspaces for Norwegian industrial companies. *Procedia CIRP*, *54*, 65-70.
Kostakis, V., Niaros, V., Dafermos, G., & Bauwens, M. (2015). Design global, manufacture local: Exploring the contours of an emerging productive model. *Futures*, *73*, 126-135.
Lindtner, S. (2017). Laboratory of the precarious: Prototyping entrepreneurial living in Shenzhen. *WSQ: Women's Studies Quarterly*, *45*(3), 287-305.
Lipson, H., & Kurman, M. (2013). *Fabricated: The new world of 3D printing*. John Wiley & Sons.
Marsh, P. (2012). *The new industrial revolution: Consumers, globalization and the end of mass production*. New Haven: Yale University Press.
Moreau, C. P. (2011). Inviting the amateurs into the studio: Understanding how consumer engagement in product design creates value. *Journal of Product Innovation Management, 28,* 3, 409-410.
Morozov, E. (2014, January 13). Making it. *The New Yorker.* Retrieved from http://www.newyorker.com/magazine/2014/01/13/making-it-2
Niaros, V., Kostakis, V., & Drechsler, W. (2017). Making (in) the smart city: The emergence of makerspaces. *Telematics and Informatics*, *34*(7), 1143-1152.
Norman, D. A. (2010). The Transmedia design challenge: Technology that is pleasurable and satisfying. *Interactions, 17,* 1, 12-15.
Norton, M. I., Mochon, D., & Ariely, D. (2012). The IKEA effect: When labor leads to love. *Journal of Consumer Psychology, 22,* 3, 453-460.
Rogers, H. (1997). "The good are not always powerful, nor the powerful always good": The politics of women's needlework in mid-Victorian London. *Victorian Studies, 40*(4), 589-623.
Rosner, D. K., & Fox, S. E. (2016). Legacies of craft and the centrality of failure in a mother-operated hackerspace. N*ew Media & Society*, *18*(4), 558-580.
Sabel, C. & Zeitlin, J. (1985). Historical alternatives to mass production: Politics, markets and technology in nineteenth-century industrialization. *Past & Present, 108.*
Schmidt, S., & Brinks, V. (2017). Open creative labs: Spatial settings at the intersection of communities and organizations. *Creativity and Innovation Management, 26*(3), 291-299.
Schorman, R. (1996). Ready or Not: Custom-Made Ideals and Ready-Made Clothes in Late 19th-Century America. *The Journal of American Culture, 19,* 4, 111-120.
Toombs, A., Bardzell, S., & Bardzell, J. (2014). Becoming makers: Hackerspace member habits, values, and identities. *Journal of Peer Production, 5*.
van Holm, E. J. (2017). Makerspaces and local economic development. *Economic Development Quarterly*, *31*(2), 164-173.
Von Hippel, E. (2005). *Democratizing innovation*. MIT press.
Watson, M. & Shove, E. (2008). Product, competence, project and practice. *Journal of Consumer Culture, 8,* 1, 69-89.
Zipkin, P. (2001). The limits of mass customization. *MIT Sloan Management Review, 42*(3), 81-87.
Zwick, D., Bonsu, S., & Darmody, A. (2008). Putting Consumers to Work. *Journal of Consumer Culture, 8,* 2, 163-196.