ABSTRACT
The use of ornament in public space has been contested throughout history, and attitudes towards the articulation of building surfaces have shifted over time. Antoine Picon has argued that the use of ornament to communicate meaning and identity is returning to a place of cultural prominence. Well-established digital design and fabrication technologies have given rise to projects that integrate performance and aesthetics through the exploitation of form, pattern and ornament. These techniques allow the designer to inscribe and overlay data generated through performance simulation and environmental analysis, and formal relationships and fabrication processes onto materials and spatial fields, creating novel configurations and effects.

Operating at a scale between object and building, public art, sculpture and architectural ornament allow for a particular type of interdisciplinary experimentation and hybrid practice. Three recent public art proposals illustrate an approach that composites multiple datasets to generate new relationships between aesthetic, environmental and functional considerations in order to activate public space. The proposals presented here put forward a set of tactics that can be deployed towards embedding overlapping data in public spaces. These proposals use pattern to form and form to pattern workflows as a way to produce multiple potential readings through pareidolia. This paper presents an investigation into how contemporary digital design and fabrication processes can bridge between performance and perception, and how ornament and pattern might be deployed for both formal and performative purposes to help foster a more personalized relationship with the urban spaces we occupy.
INTRODUCTION
In the next 20 years, the population living in cities worldwide will exceed 5 billion. Compounded by climate change and increasingly scarce resources, the challenge of humanely accommodating rapid urbanization will be a major concern in the coming decades. Well-designed, vibrant public spaces are a critical ingredient in making cities more sustainable and socially integrated. Public artworks, monuments and architectural ornament communicate the unique identity of a space to users, and in turn allow them to identify and form associations with their material context. In order for people to be able to relate to the public space they inhabit, it should reflect or communicate something about their experience and reality; in the case of contemporary urban existence, that reality is one of ambiguity and complexity. In this work we build on previous research within the University of Calgary’s Laboratory for Integrative Design that explored the relationship between computer vision and construction of the built environment in the context of ubiquitous simultaneity. In this context, spatially described big data is processed through algorithmic observation (Johnson and Parker 2014; 2016). Previous research examined how computer vision is used as a means of compositing multiple instances of representation simultaneously and speculated about the use of computation among architects as a means for reorganizing data towards the production of new urban ecologies.

One of the primary limitations of the previous work was its scale. At the scale of cities and buildings, the ability to deploy the workflows towards the production of functional and performative assemblies is limited by the processing power needed to produce highly articulated and locally defined assemblies. The workflows presented here build on this previous research, but shift in scale in an attempt to use situated pattern as a driver in the production of two- and three-dimensional surfaces. Pattern recognition is a critical aspect of both human and computer vision, and we propose that mapping and compositing layers of data onto/into objects, surfaces and spaces allows for a more precise test of both and material assemblies, and can offer insight into how these assemblies can be “read” by their users. We propose that these simultaneously layered formal patterns trigger pareidolia. Pareidolia is a psychological phenomenon defined as the process of perceiving meaningful patterns in vague or ambiguous stimuli, and is exemplified by seeing animals or faces in clouds, the man in the moon, etc. (Merriam-Webster Online). The work presented here investigates how pareidolia can be induced through the production of works of public art and architectural ornament, with the goal of activating space through user perceptions without dictating particular responses or narratives. This ornament can be deployed as a form of spatial or functional identification that is absent of overly prescribed associations with historical, contextual or cultural iconography.

We examine a series of public art proposals that deploy contemporary digital design and fabrication processes in conjunction with an understanding of how we perceive and respond to patterns and visual stimuli to help foster a sense of intrigue, delight, and a deeper and more personalized relationship with the urban spaces we occupy.

BACKGROUND
As designers attempt to synthesize the massive amounts of visual data available in the cloud, patterns and connections begin to emerge. The ability to read data created by and for digital processes, and express the layers of information through a translation to formal outputs, is a task that could become easily overburdened with either overly explicit and reductive representations, or excessively front-loaded and curated narratives. We advocate a more open-ended approach. The phenomenon of pareidolia demonstrates our ability, in some cases, to fabricate, ignore or reshape evidence to fit our preconceived notions or to reaffirm our beliefs. Zusne and Jones (2014) describe the experience of pareidolia as the foundation of the famous Rorschach inkblot test, a psychiatric assessment tool developed in 1921 by Swiss psychoanalyst Hermann Rorschach. The test involves
10 cards with inkblots on them, 5 black and white and 5 colour. Rorschach, who was also trained in the visual arts, carefully designed the symmetrical blots. He worked through numerous drafts of the blots to remove evidence of how they were made and adjusted the level of refinement to find a balance between detail and abstraction, which would generate the most revealing responses (Sears 2017).

Rorschach’s inkblots are able to generate a large quantity of associative imagery at least in part due to the fractal complexity of their edges (Figure 2). Research has shown that there is an optimal bandwidth of fractal patterns that produce the most imagery, and it may be possible to “tune” how much people see in inkblots by adjusting the level of fractal complexity of the blots (Taylor et al. 2017).

For centuries, artists have experimented with using ambiguous visual stimuli to represent multiple potential truths in a single instance. In the paintings of Vermeer, composition, colour, shadow, light and texture allow the subject’s facial expression to be interpreted in a variety of ways. Modern visual artists like Mondrian and Malevic experimented with ambiguity and abstraction in order to analyze the fundamental aspects of perception in the early 20th century (Malgrave 2010). Subsequent generations of artists, from the Surrealists to Pollock and Warhol, have continued to use pareidolia as a way of triggering associative imagery (Taylor et al. 2017).

Johnson and Parker connect digitally induced “glitches” (2014) to contemporary design practices that increasingly appropriate techniques derived from computer vision, such as aggregation, dissection and blending in the production of composited communicative surfaces/images. This research speculated about how these techniques might also be used as a form of resistance against data-driven algorithms through the intentional production of glitches for the purposes of camouflage or emergent formal strategies.

Pareidolia presents a number of interesting potential avenues for further investigation in the visual arts and sciences, with applications ranging from camouflage to computer vision and facial recognition systems (Taylor et al. 2017). Another area of application, and the one discussed here, is the design of public art and architectural ornament. Antoine Picon (2013) describes ornament as “a kind of mirror. In this mirror, we see ourselves as we believe we are and as we would like to be. Ornament is inextricably about knowledge and illusion. Although tainted with dreams (but is this not always the case with what is in our mind?), the knowledge component appears essential.”

Ornament in public buildings and spaces has been contested throughout history. With his well-known essay “Ornament and Crime,” Adolf Loos (1997) called for modern architects to repress the urge to decorate, or at least subordinate it to other considerations. Venturi’s “Complexity and Contradiction in Architecture” (1977) challenged the exclusivity of notions of purity, architectural order, symmetry, and harmony championed by orthodox modern architects. He cites a number of examples and argues that their resonance arises from the underlying tension and inherent contradiction, and suggests that intentional (as opposed to accidental) ambiguity allows for a richer and more meaningful architecture.

If today our attitude towards architectural ornament has shifted, returning it to a place of cultural prominence, we should explore this through the range of tools available to the designer (Picon 2013). Instead of being handcrafted, or even mass produced, contemporary architectural ornament is mass-customized, digitally designed and fabricated, and expressed through form, materiality, pattern, and articulation. New technologies are allowing for new types of spatial patterns and new possibilities for the integration of structure, ornament and space, as well as endless possible configurations (Garcia 2009). The configuration and versions of these articulations need not be limited to any given instance and could in fact use overlapping sets of instances to induce endless readings.

The work presented here links research into vision, perception, pattern and pareidolia, which is in some ways a glitch in human perception, with a body of research concerned with the computationally driven fabrication of material structures. This work acknowledges the precedent of work by designers like Andrew Kudless in his P-Wall series, where underlying patterns and restrictive edges form constraints to a plastic material process, or Mark Foster Gage’s Kitbashing projects, which embed and intersect known and highly legible spatial objects into elaborately symmetrical assemblages. Our approach argues for a less precise reading of the visual source material found in a number of contemporary projects that aggregate natural, cultural and industrial icons into assembles while retaining the legibility of the initial objects. Here we investigate the potential for digital design and fabrication tools to translate data and inscribe complex patterns onto surfaces and forms, and for aggregated forms to be interpreted as more than complex patterns. The work seeks to leverage our tendency to augment and project meaning onto pattern, and thereby use pareidolia as a communicative tool to add richness and subjective meaning to architectural space.

**PATTERN/FORM TRANSLATIONS**

Three recently completed proposals deploy pareidolia in the
design of architectural ornament, public art and public space. The projects share a common thread of translation between pattern and form. The patterns emerge from data sets generated by analysis of historical documents, images and procedural geometrical translations. The projects differ in the way that the translation occurs. In the case of the first two projects, pattern is translated into form, while in the case of the final project, form is translated into pattern.

2D Pattern to 2D Form

"The Crest and the Crown" is a proposal for a chandelier and panelized ceiling installation forming an entry sequence to an adaptive reuse project in Calgary’s historic King Edward School building. The ceiling panels are a composite construction of CNC milled repurposed materials, including wood and inlaid brass, and milled translucent panels mounted to a modular dropped ceiling system. The pattern is a derivation of the school crest taken from a drawing in a historic school yearbook. The materiality of brass and wood is derived from details, furniture and accents found throughout the historic building (Figure 3).

In the generative process, patterns emerge through a series of digital translations of historic data. The crest, derived from the historic school crest, uses a set of rotations and mirroring operations around a hexagonal module to produce a vector field for generating tool paths. The modules are mirrored and arrayed along their axes to produce an aggregated pattern (Figure 4). The pattern thickness is built up through accumulation of layers and results in a new "crest" for the building. This crest embeds both the historical two-dimensional image and the processes of
duplication through mirroring/rotating. Similar to the mirroring process used by Rosarch in his inkblotting studies, this new crest becomes legible through the material definition of solids and edges.

**2D Pattern to 3D Form**

“The Crown” references the colonial iconography of the crown, distorted through a process of anamorphic projection, digitally simulated restrained inflation and contouring (Figure 5). Taking the form of a chandelier constructed out of stacked translucent panels lit from the interior, the object is designed to hang from the ceiling of a small vestibule space between the entry and the main stairs. The Crown is visible from below and through a window between the vestibule and the entry stairs. It acts as a link between the interior spaces of the building and the proposal for the exterior columns. Its changing position in relationship to the viewer, combined with its translucent materiality, lends itself to a continuously shifting set of readings. Symmetrically arrayed morphologies and the billowing nature of the inflation give
simultaneous readings of biological and meteorological bodies and formations.

The proposal for the exterior elements employs a similar workflow of translating 2D patterns derived from historical data to 3D form. "Columnulous" uses the historic documentation of the building as a departure point for the design of a series of monuments resembling columns of cloud formations to act as a threshold for the public plaza at the south entry of the building (Figure 6).

The design process involved sampling details from the original 1912 architectural drawings of the sandstone building and projecting them onto column masses. By referencing recognizable instances from the façade and indexing them to the column locations, they subconsciously and indirectly draw the viewer's attention to the patterns contained within the building elevation. The projected lines act as restraints to the masses as they are inflated using a physics engine. The process of inflation can be seen as a way of obscuring or "clouding" these details so that viewers will overlay their own interpretations and associations onto the form. This pareidolic instancing was used to explore the extent to which the geometries and patterns should be obscured in order to encourage a range of associations (Figure 7).

The column shapes were then trimmed and the resulting geometries are a combination of soft forms and hard edges fabricated in concrete cast in CNC milled molds (Figure 8). Viewers experiencing these intentionally ambiguous forms would be able to follow a similar procedure of projection and editing, translating their own subjectivity onto the work. The objects can be read a number of ways at the same time, and resemble both soft, fluid forms and rigid concrete monoliths. They operate in series and as single sculptural instances. The inscribed patterns reference the adjacent building, but are obscured in a way that allows them to read simultaneously as contextual and alien (Figure 8).

3D Form to 2D Pattern

Limenitis Wall, installed on a south-facing façade of the Emerald Hills Sports Pavilion, uses a methodology that inverts the previous examples. In this case, a process-intensive prototyping phase informed by feedback loops and driven by hands-on experimentation resulted in the development of a formal assembly. In contrast to the first two examples, rather than obscuring or augmenting patterns to generate formal elasticity, a component was developed from material principles and then aggregated into a differentiated pattern. The formal strategies for the component were developed by referencing local plant and insect species through a material process of “curling/rolling” and perforation.

The performative intent of the project as a material system was to produce a surface with the capacity to resist solar exposure and drastic temperature differentials without buckling or oil-canning, to structurally withstand the risk of hail and snow-loads, to direct runoff and snow melt, to exploit shifting lighting conditions,
and to weather in place. Gradually the finished surfaces of the work will be allowed to deteriorate while simultaneously encouraging the accumulation, deposition and emergence of organisms and material as it is exposed to the changing seasons, following a similar path to the one described by Andrew Kudless in his P_Wall (Weathering) project (Figure 9) (Kudless 2011). This deterioration takes the form of differential fading of surfaces based on the processes of finishing used to treat the aluminum sheet materials.

The project was developed through parallel streams of digital modeling, analysis and visualization alongside rigorous and iterative physical prototyping. A parametric model was the intermediary between these two streams. The model employed a variable subdivision of a diagrid pattern to aggregate curved and folded components on a surface to produce a fractal pattern with multiple levels of subdivision.

Initial rough prototypes were fabricated in paper and plastic, and quickly scaled up to half- and full-scale aluminum (Figure 11). The components evolved in several iterative stages from a single element riveted together, towards two interlocking pieces with tabs and slots located to hold specific curvature. This compound geometry bolts to a tab and attaches to the structural frame.

The process of developing the components through the symmetrical cutting of sheet material, using a variety of materials, rendered a range of layered material effects. Aluminum was chosen as a lightweight, easily machined and durable material capable of producing curvature, reflection and accepting surface variations through a number of treatment methods. A number of variables informed the scale of the components, including the ductility of the metal sheets and the curvature radiiues they afforded. By forming the aluminum into curved surfaces using a roller and locking positions through interlocking tabs, the components gained a great deal of structural rigidity reinforced through the addition of a second layer (Figure 12).

Throughout the physical prototyping process, a series of adjustments where made to the sheet material in order to allow for uniform bending performance and to increase the speed of production. The application of perforation patterns to the components in specific regions reduced the material resistance to rolling and increased the precision of the curve radii without negatively affecting the strength of the components. The precision of the perforation pattern was guided using digital curvature analysis tools to ensure that the areas of highest curvature received the highest density of holes within a given tolerance. A secondary benefit of the perforation pattern is that it adds an additional layer of resolution that enhances the differentiated surface qualities of the piece (Figure 13).
In addition to the surface qualities introduced by the perforations into the curved surfaces, we explored a number of surfacing strategies that might affect the ways in which the surfaces performed. These areas of performance included reflectivity, management of precipitation (freeze/thaw cycles) and heat absorption. These strategies included sandblasting, anodizing or leaving the surfaces untreated. Each of these treatments could be applied across both surfaces making up a component or controlled on an individual surface basis. A parametric scenario model was developed to iterate through the potential patterns generated by these variables. These scenarios were tied to image maps that constrained the larger pattern while assigning attributes to each individual component (Figure 14).

The components are affixed to an aluminum diagrid structural frame mounted to the wall of the sports pavilion. The diagrid frame is mostly concealed by the components, but was chosen because it reinforced and enhanced the logic of the overall pattern and visual effects. The framing system also allowed for rapid deployment on site, as required by the short winter days available for installation, and the precision needed to attach to the previously located anchor points on site (Figure 15).

The work evolved from an investigation of formal and material characteristics of the components to an aggregated surface pattern in response to an interpretation of the site (a sports pavilion) as a place where people are in a state of constant interaction and motion. It seeks to abstract these forces at multiple levels of resolution. Vaguely referencing human faces or animal forms in motion, the work visually activates the façade of the building. The intent was for layers of information embedded in form, material, colouration and texture to interact with the
ephemeral qualities of rain, snow and the changing light conditions to form new patterns and new readings of the work (Figure 16–18).

Since the work was installed, viewers have commented that the work brings to mind a range of associative imagery including butterflies, pieces of armor, faces, masks, movement, and a combination of feminine and masculine forms in the parts and the overall composition. These comments suggest that a post-installation set of surveys might reveal insights into the ways in which the piece is read and to what extent the number of parts, their scales and relationships play a role in its legibility. As the work is absorbed into the site and the environment, it may continue to provide new opportunities to learn about projection and perception. This process of evolution and transformation points towards the potential for pareidolia to be a tool to enhance communication.

CONCLUSION
Design is inherently complex, ambiguous and open to multiple potential interpretations. In order for people to be able to relate to the public space they inhabit, it should reflect this contemporary reality. Architectural ornament and public artworks have been used didactically through history. Historically, the function of ornament was to tell us what type of building we were entering, how we should behave and what to expect. Contemporary urban environments and the way in which they are materially articulated should be able to communicate across a broader spectrum of users and contexts. Understanding pareidolia and how it can be induced through ambiguity and pattern may help designers to activate space and engage the public without dictating a certain type of response in order to produce meaning and reflect contemporary culture and identity.

In reflecting on these projects, a set of unique common threads start to emerge. The design of Limenitis Wall, Columnulous, and The Crest and the Crown represent an attempt to overlay and allow several organizational systems to interact while at the same time obscuring identification and categorization. These projects operate at multiple scales, respond to their environmental and historical contexts and deploy a set of specific techniques including subdivision, coloration, perforation, curvature, aggregation and asymmetry in order to trigger a sense of pareidolia and
encourage people to project their own meanings onto the work. The result is a richer and more inclusive association with the work and the public space it occupies.

The potential for pareidolia to operate as a tool to induce interpretation depends on a number of factors. These projects have begun to test some possible techniques. Further research is continuing to refine these techniques in order to tune the bandwidth of ambiguity and complexity in the way that patterns of information and fractal imagery are overlaid. If the patterns are either too ambiguous or too simple, it is unlikely that the work will maintain the viewers’ attention for long enough to trigger their pattern recognition system and allow them to begin to form narratives and associations with it. Current projects are focused on embedding user groups into the generative processes for pareidolic form finding and the subsequent readings of its outcomes.

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REFERENCES


IMAGE CREDITS
Figures 4 and 5: Jason S. Johnson, Matthew Parker, 2016
Figure 9: Andrew Kudless, 2011
All other drawings and images by the authors.

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