Computing for Generative Justice: decolonizing the circular economy

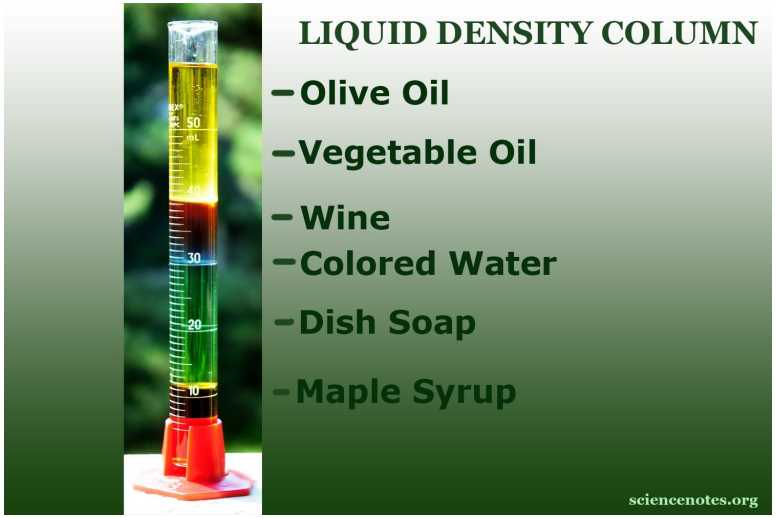
Ron Eglash, University of Michigan

Some knowledge is socially constructed:

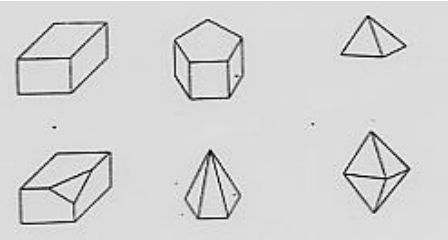
Which is the most delicious food? There is no universal, objective answer.

Some knowledge is objective:

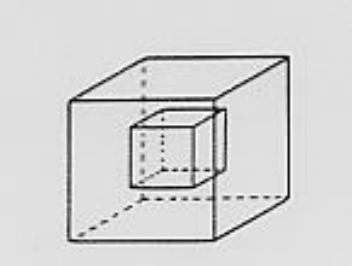
Which of these liquids has the greatest density? You don't even need a human, the liquids will sort themselves.



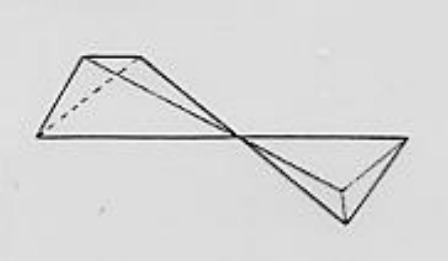
Knowledge *systems*: both objective AND socially constructed aspects. Example: the history of Euler's law



1752: Euler proposes relation of Vertices, Edges, and Faces: V - E + F = 2. Polyhedra are defined as "a solid whose faces are polygons."



1815: Hessel's cube with a cubic hollow inside does not satisfy Euler's theorem. A fight! Euler wins. Polyhedra redefined: "a surface made up of polygonal faces."

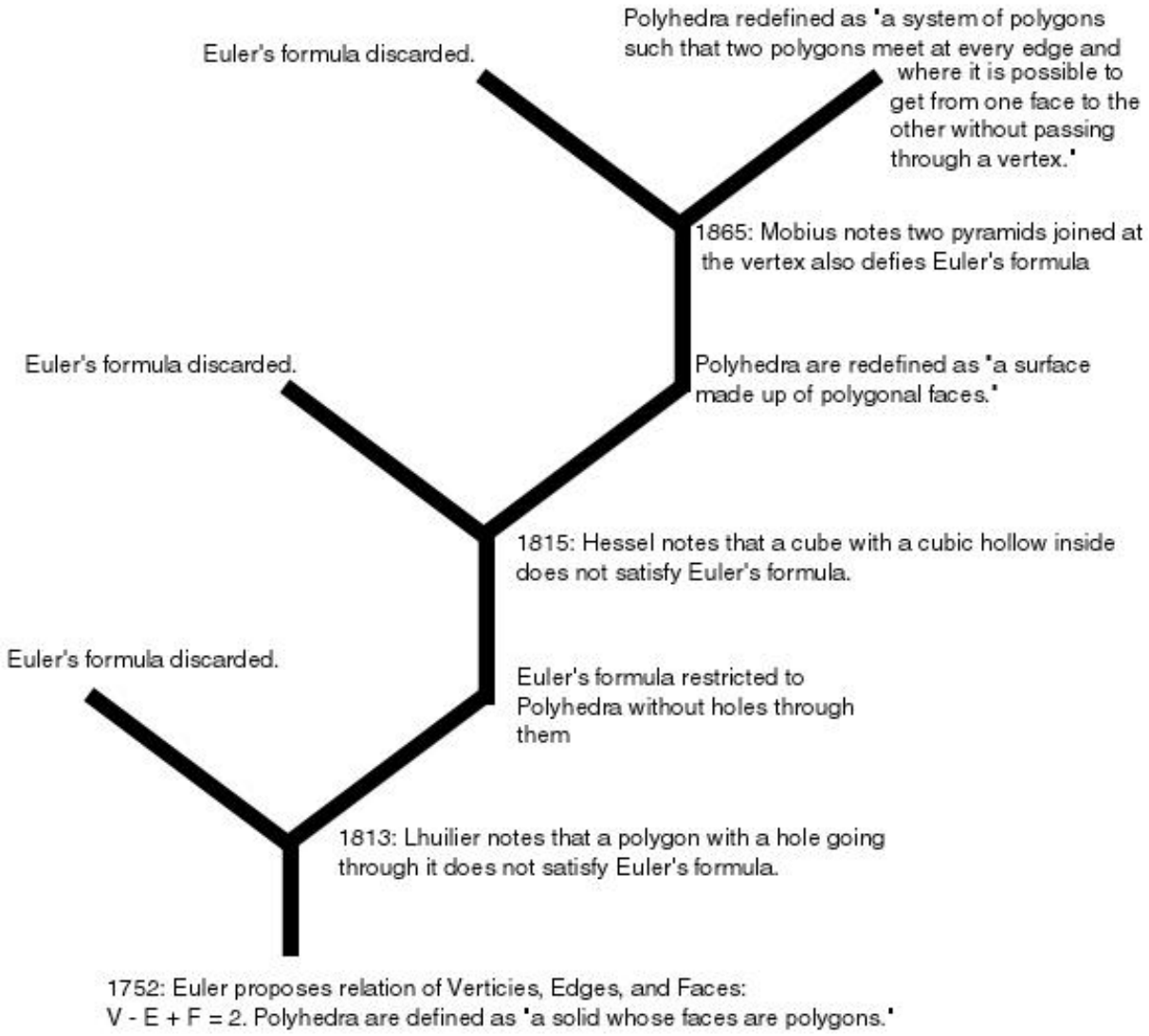


1865: Mobius notes that two pyramids joined a the vertex also defies Euler's theorem. A fight! Euler wins. Polyhedra redefined as "a system of polygons such that two polygons meet at every edge and where it is possible to get from one face to the other without passing through a vertex."

Eglash, R. (2011), "Multiple objectivity: an anti-relativist approach to situated knowledge", *Kybernetes*, Vol. 40 No. 7/8, pp. 995-1003

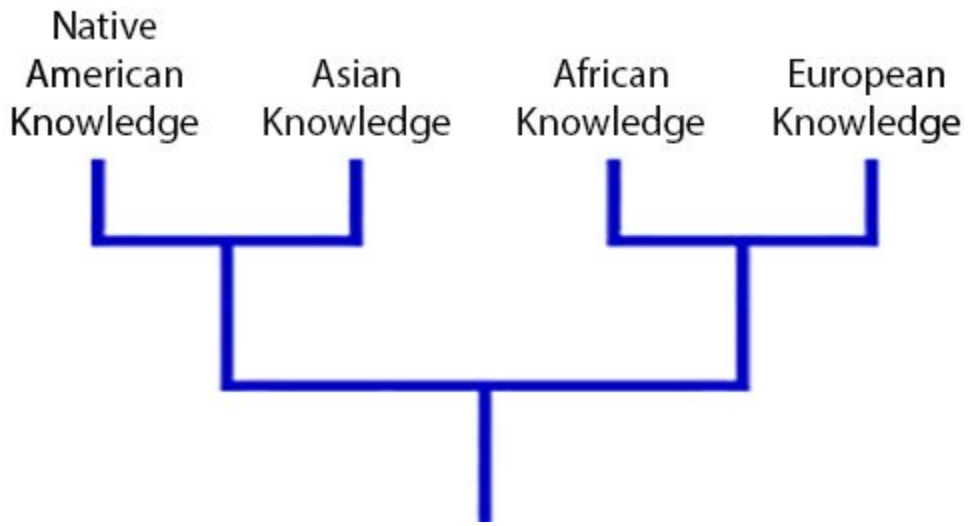
Each branch point is a math we could have pursued

(but did not!)



Pickering: each branch point is a "mangle" of human and non-human agency

Branch points in cultural evolution

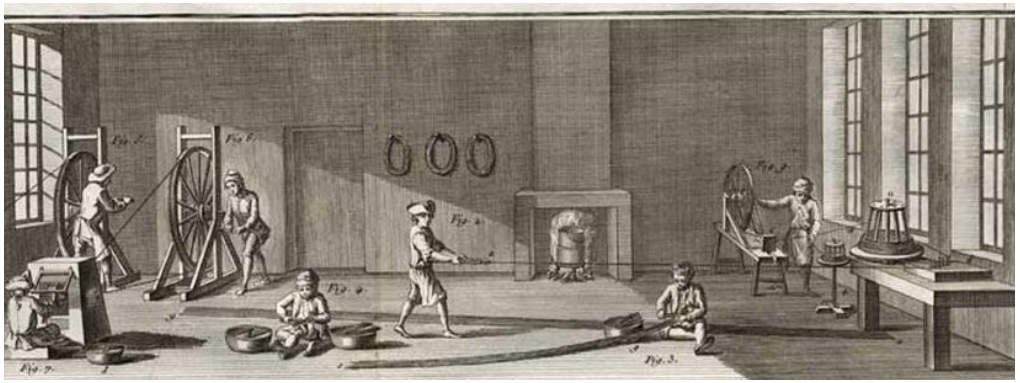


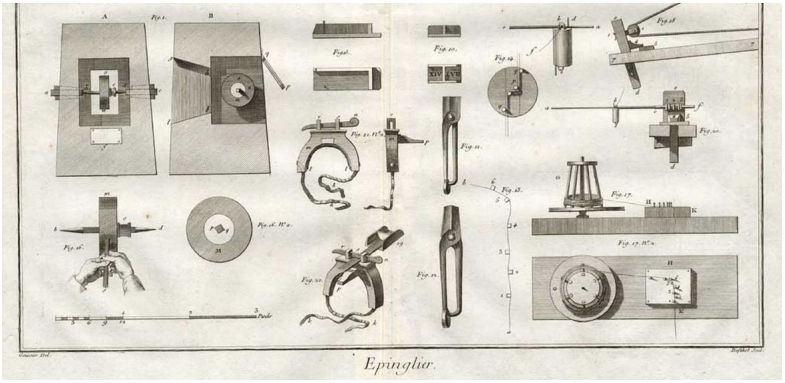
Obviously this is an over-simplification -- the branches are entangled.

There is no "primitive" knowledge, just branch points where knowledge systems diverged

What was Europe's branch point of divergence?

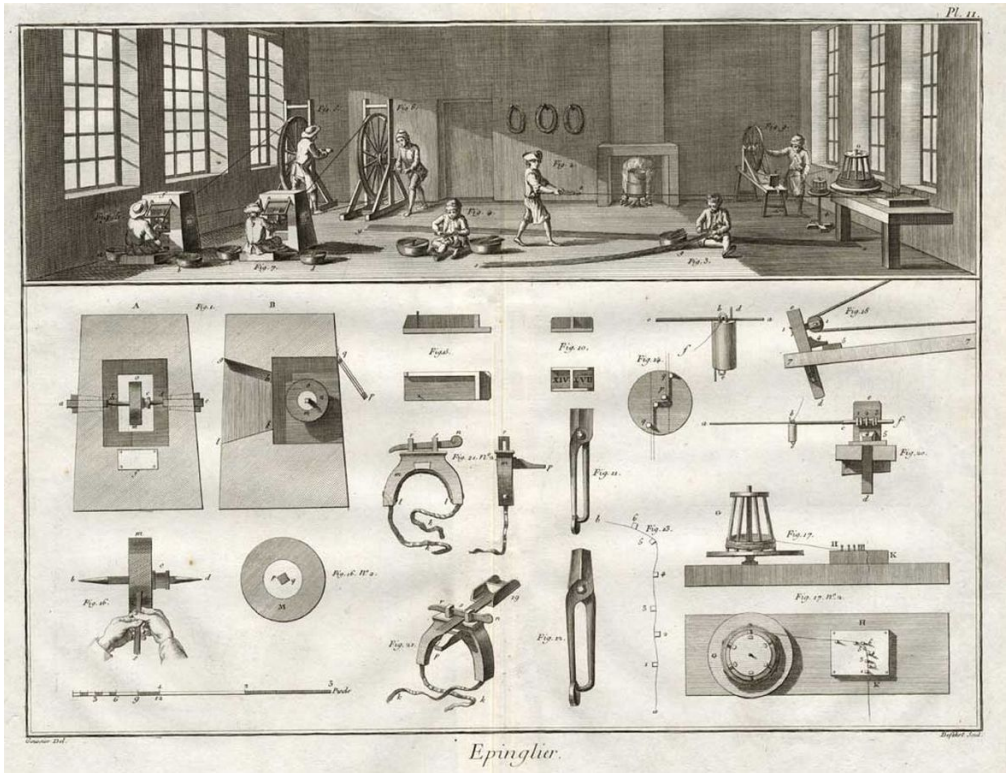
Europe: Extractive Economy and Extractive STEM Co-Evolve





Economics	Science and Technology
Skilled employees demand high pay. Break into little tasks: “deskilling”	Physics: Efficiency metaphor defines relation of energy to work: extracting maximum work for minimum effort.
Borrows term “efficiency” from physics: deskilling is just following Nature’s laws	Engineering: defines: tool design driven by Smith’s deskilling goals
Competition in technology requires business advances in accounting and logistics for extraction	Computing: Charles Babbage cites Adam Smith’s pin factory as model for computer

Europe: Extractive Economy and Extractive STEM Co-Evolve



“Poor people? Well, that’s just part of nature. You cannot argue with the laws of physics!”

European economies of extraction inspired the kinds of science and technology that serve that purpose.

If you believe that is the only kind of science possible, then optimizing for the extraction of value from workers seems like an inevitable law of the universe. BUT IT’S NOT

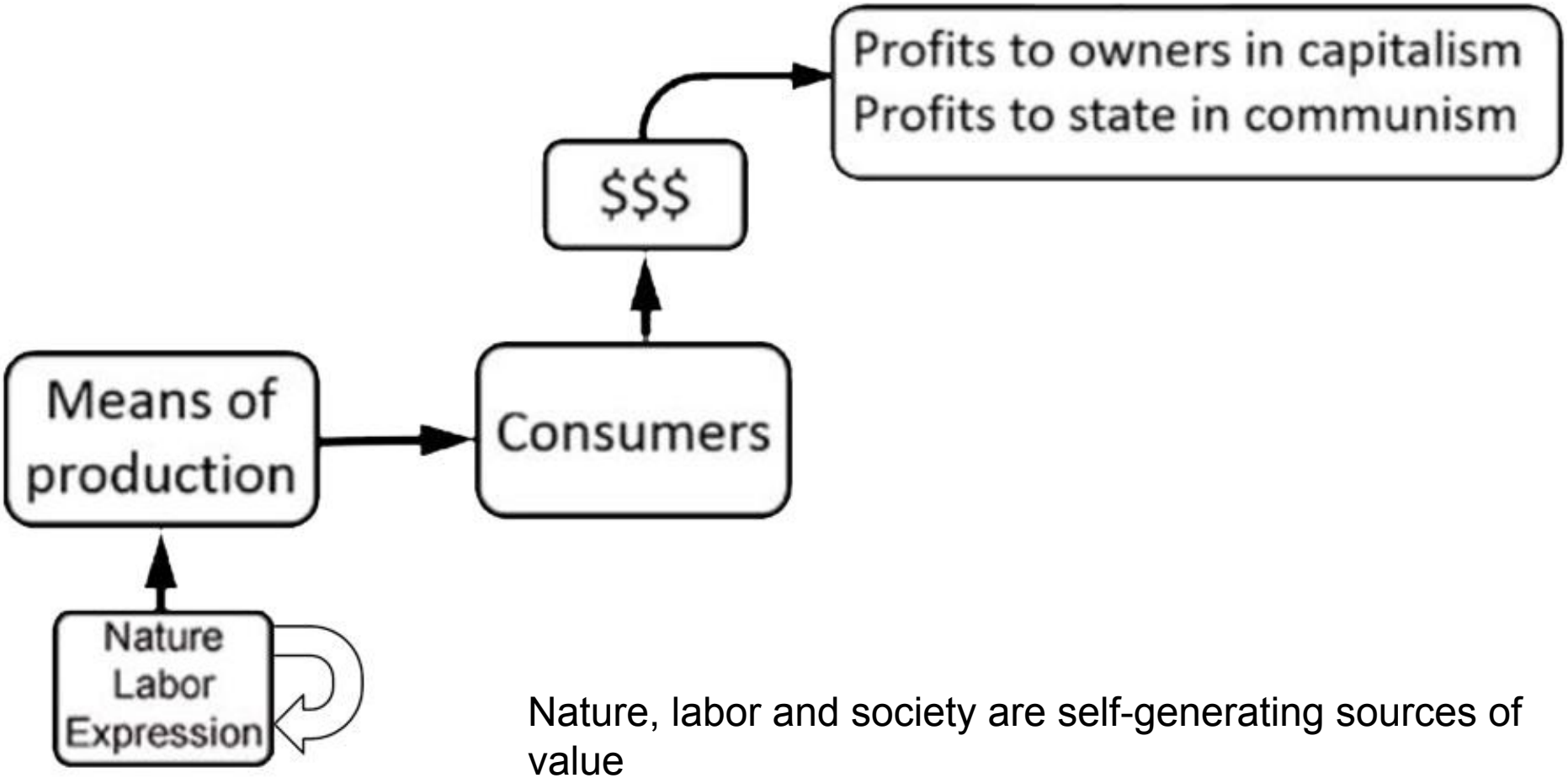
Western knowledge's branch took a wrong turn in seeking the *extraction of value*

Extracting ecological value from pollution and overharvesting

Extracting labor value from low paid, unfulfilling jobs

Extracting social value by colonizing our landscape, physically and online

Both capitalism and communism: **extraction of value**

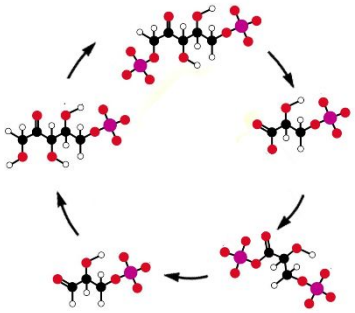


Nature, labor and society are self-generating sources of value

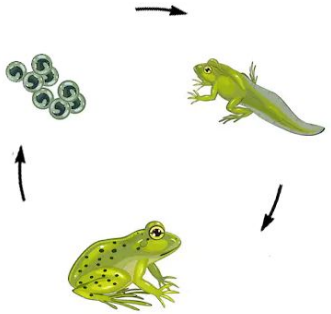
But their value is **extracted; alienated from its source**.

Nature does not extract value, it circulates it

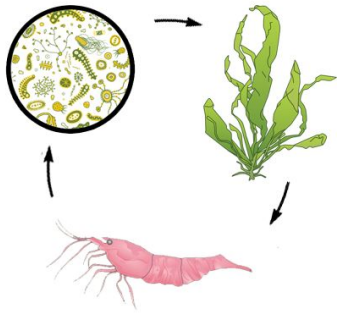
Biomolecules:
autocatalysis



Organisms:
autopoiesis



Ecosystems:
sympoiesis

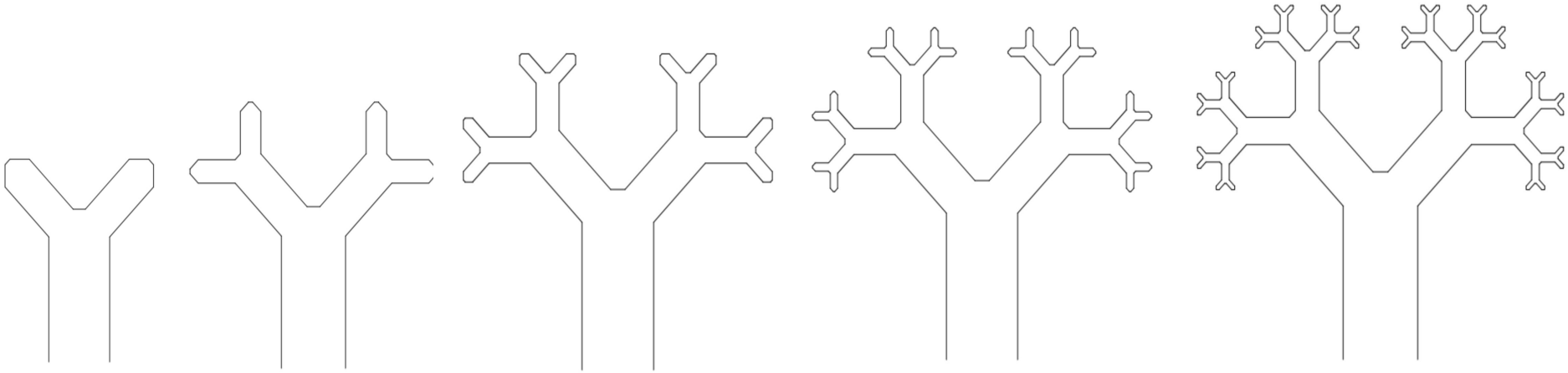


At every scale, the power of life is due to <u>self-generation</u>

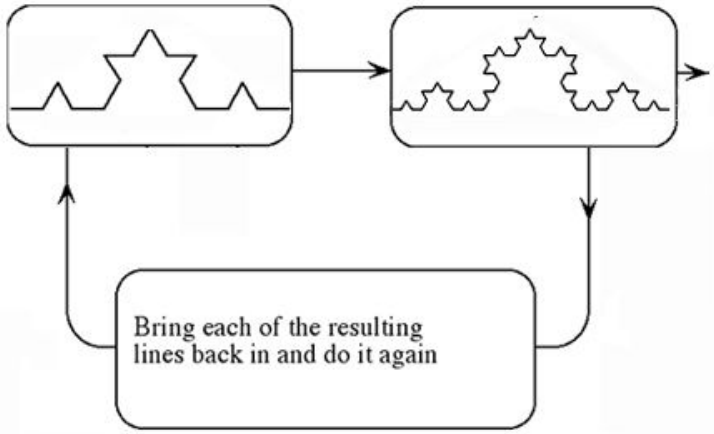
Erwin Schrödinger: “negative entropy”

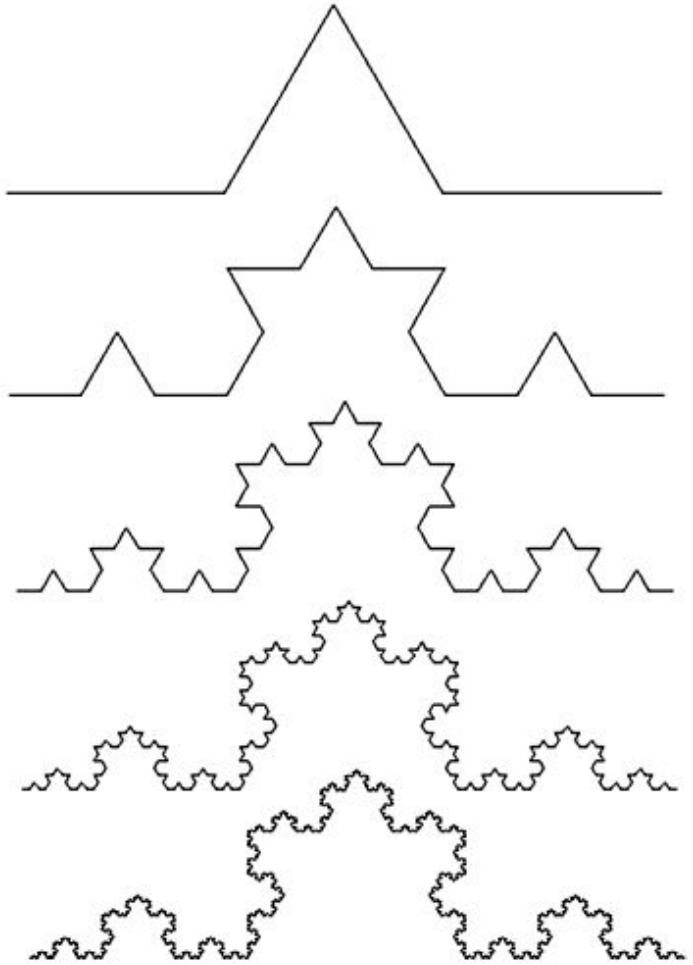
Indigenous traditions also used this recursive loop of circulating value

Nature uses fractal geometry, because of its bottom-up emergence

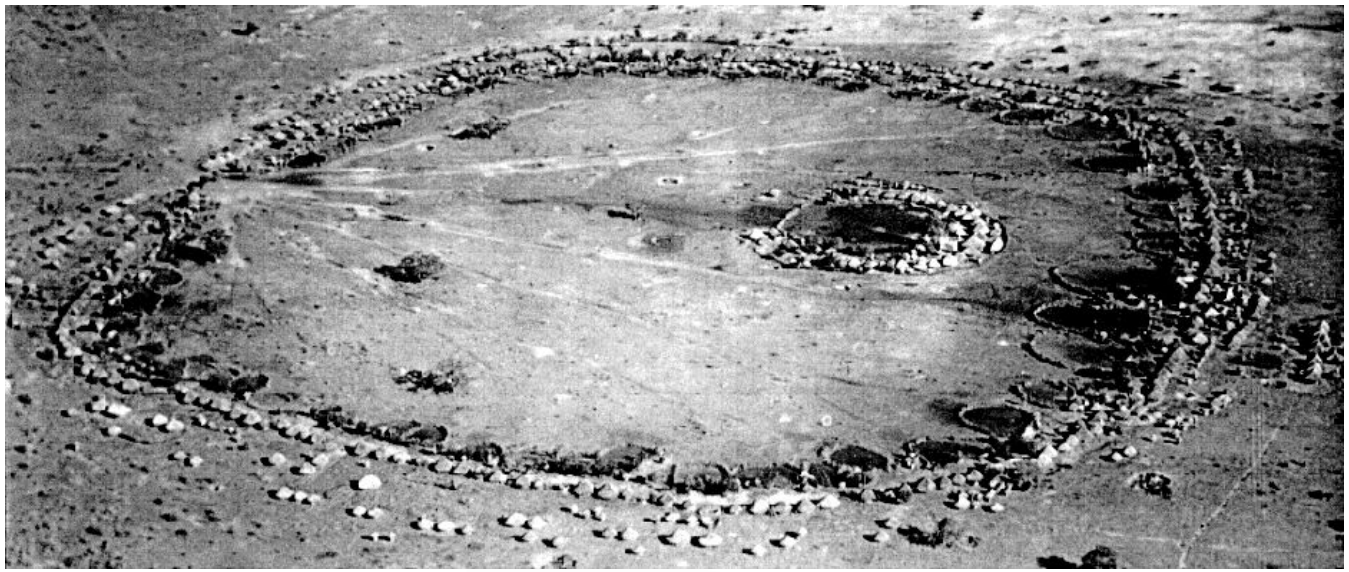


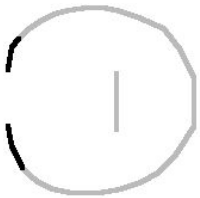
Fractals are patterns that repeat at many scales, typically created by a “bottom-up” cycle

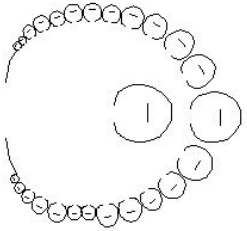


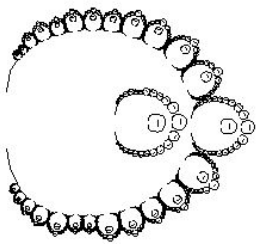


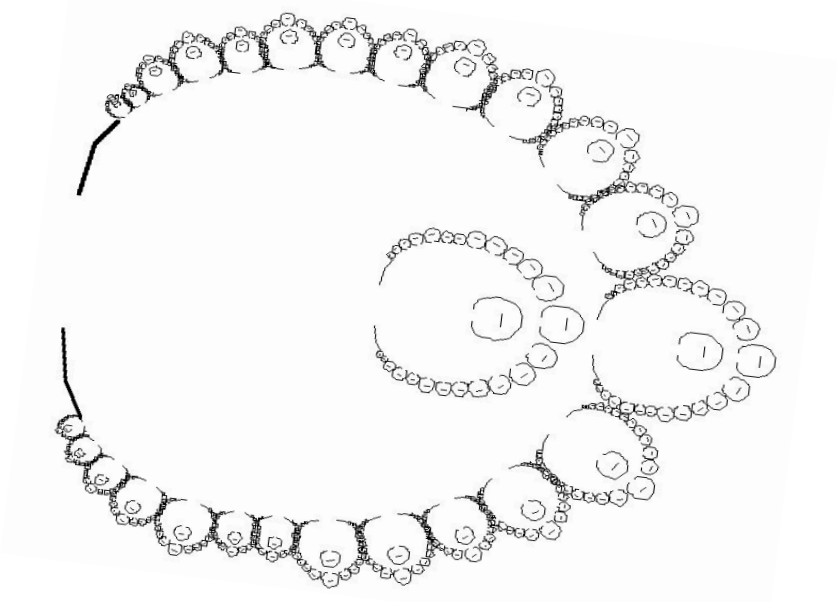
Africans are using bottom-up organization, and creating fractal forms as a result.



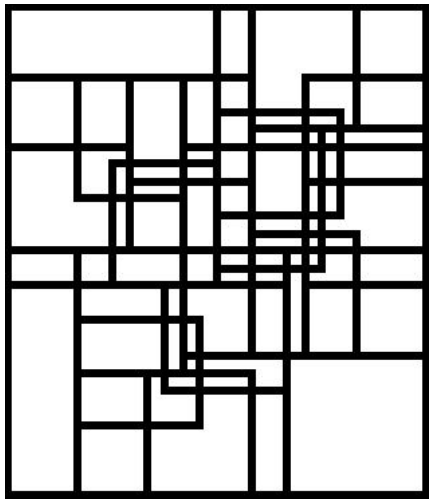


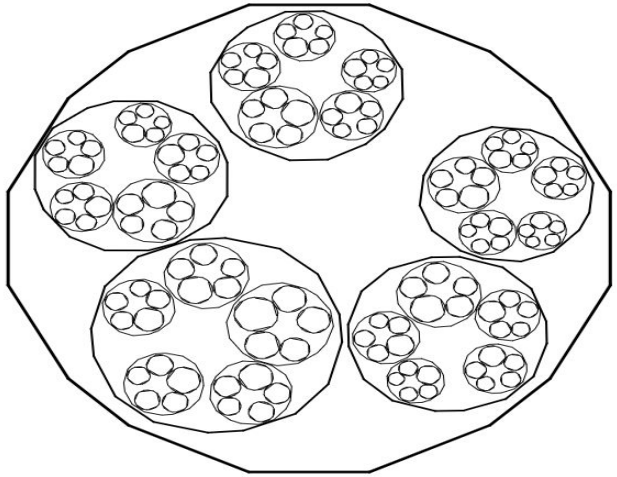




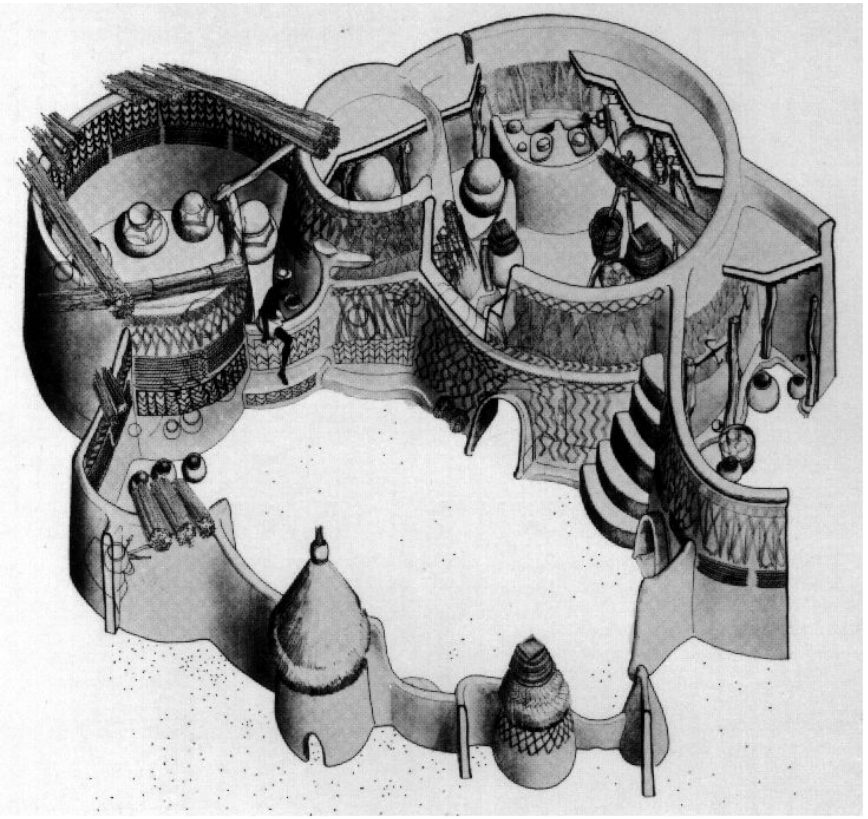


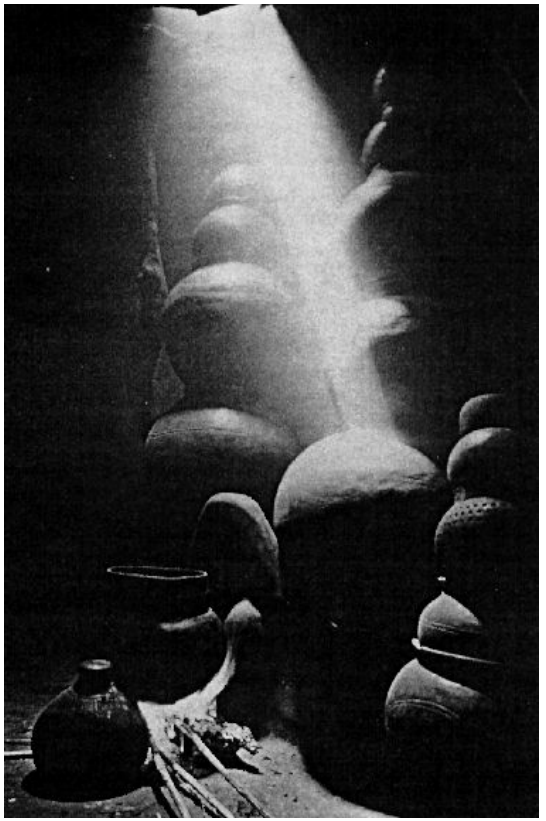
I was often told fractals in African architecture must be unintentional--but evidence shows otherwise



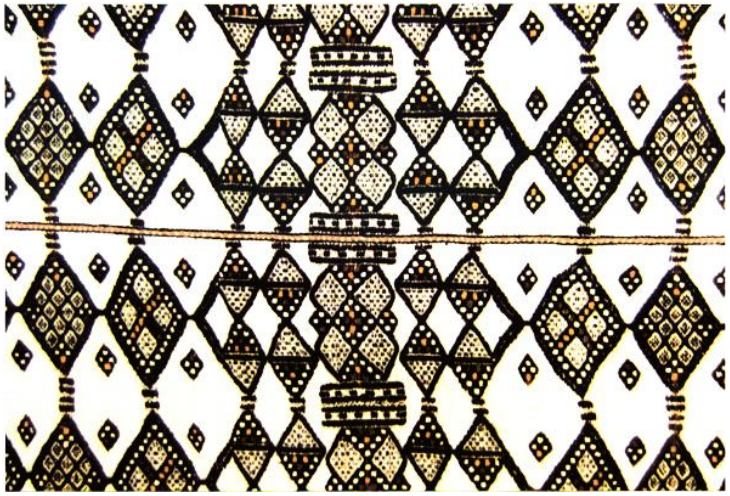


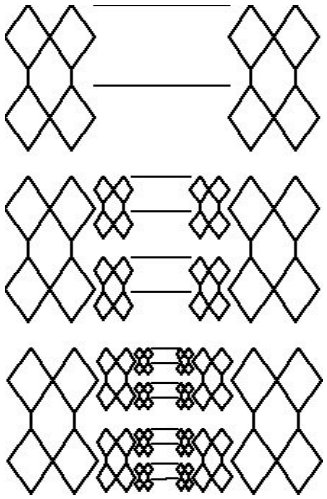
The recursion--shapes within shapes--is used to symbolize ancestral relations and other spiritual meanings

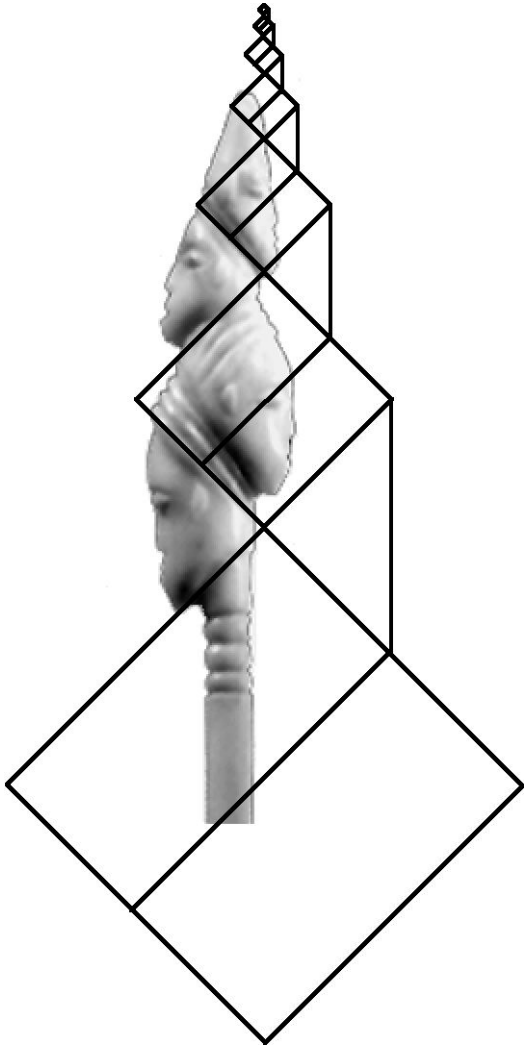


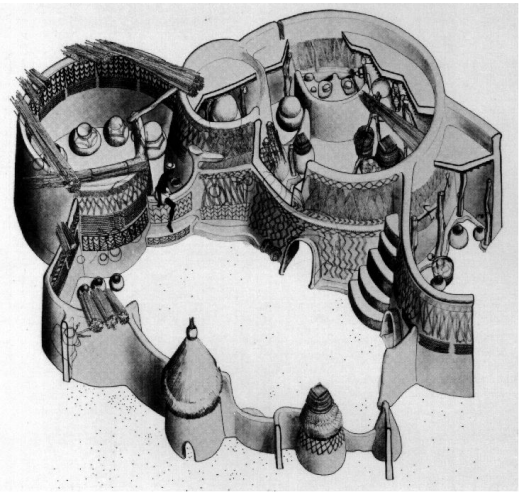


Recursive scaling is a conscious theme in African design

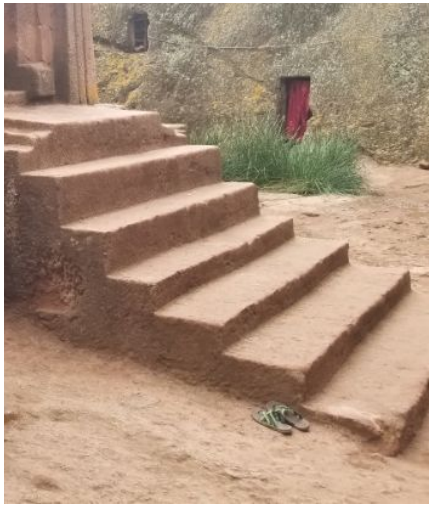


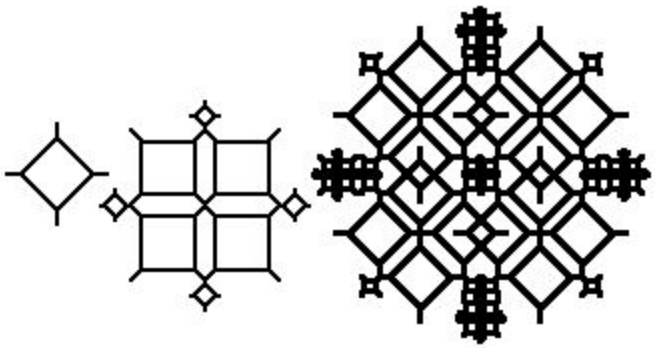


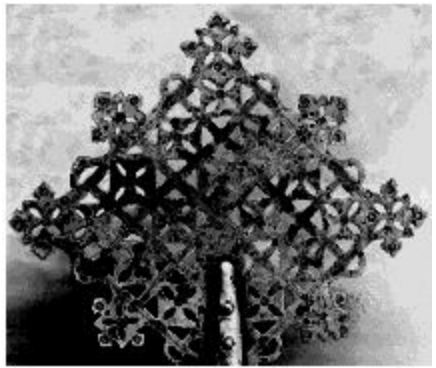




Heritage Algorithms: African case includes intentional cycles of nonlinear scaling







Africa’s fractal heritage in the Americas

Architecture could not be brought along, but the concepts of recursion and nonlinearity came via cornrow braiding, quilting, growing traditions,, making traditions, spiritual concepts and so on.

Not just symbolic: cycles of unalienated value flow form the traditional generative economy

Bark grows on tree

Biodiversity in sacred forest

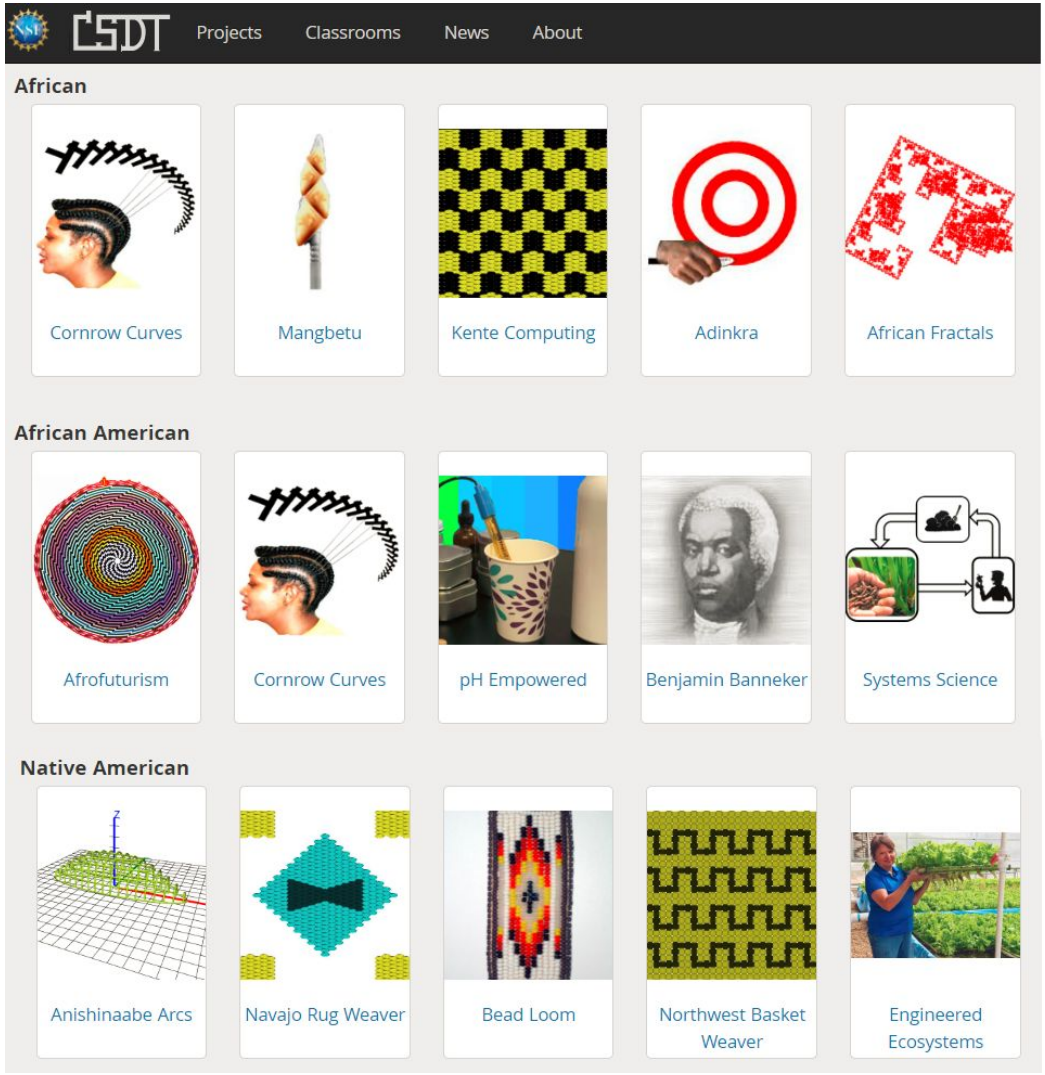
Bark boiled for ink

Strained bark composted

Western STEM was created for value extraction
Indigenous STEM's goal is to <u>prevent</u> extraction, and nurture cyclic generation

We have trouble recognizing Indigenous STEM: because we are blind to generative technologies

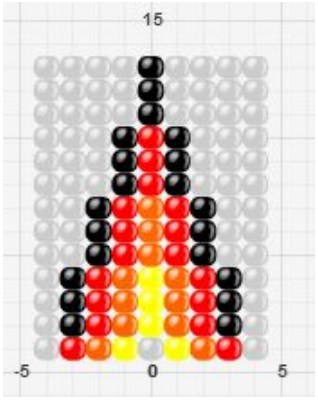
Ethnocomputing uses simulations to translate Indigenous Knowledge to a heritage algorithm



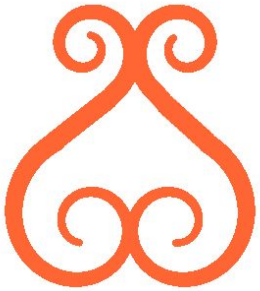
Culturally Situated Design Tools (csdt.org)

CSDTs: indigenous ethnocomputing

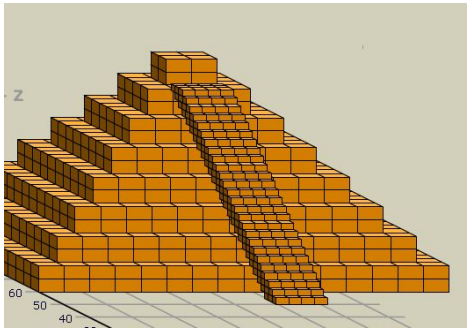
Virtual Beadloom



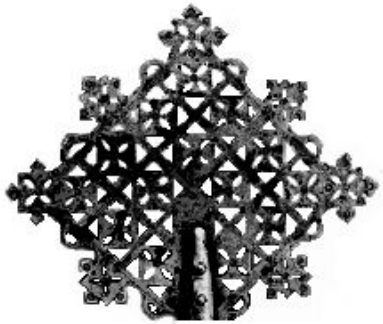
Adinkra Grapher

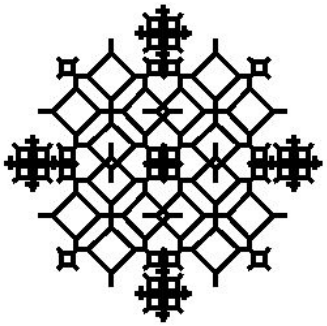


Precolumbian Pyramids

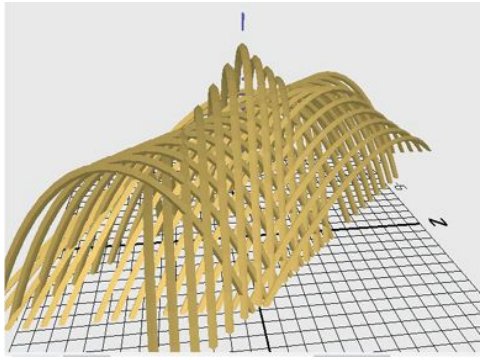


African Fractals



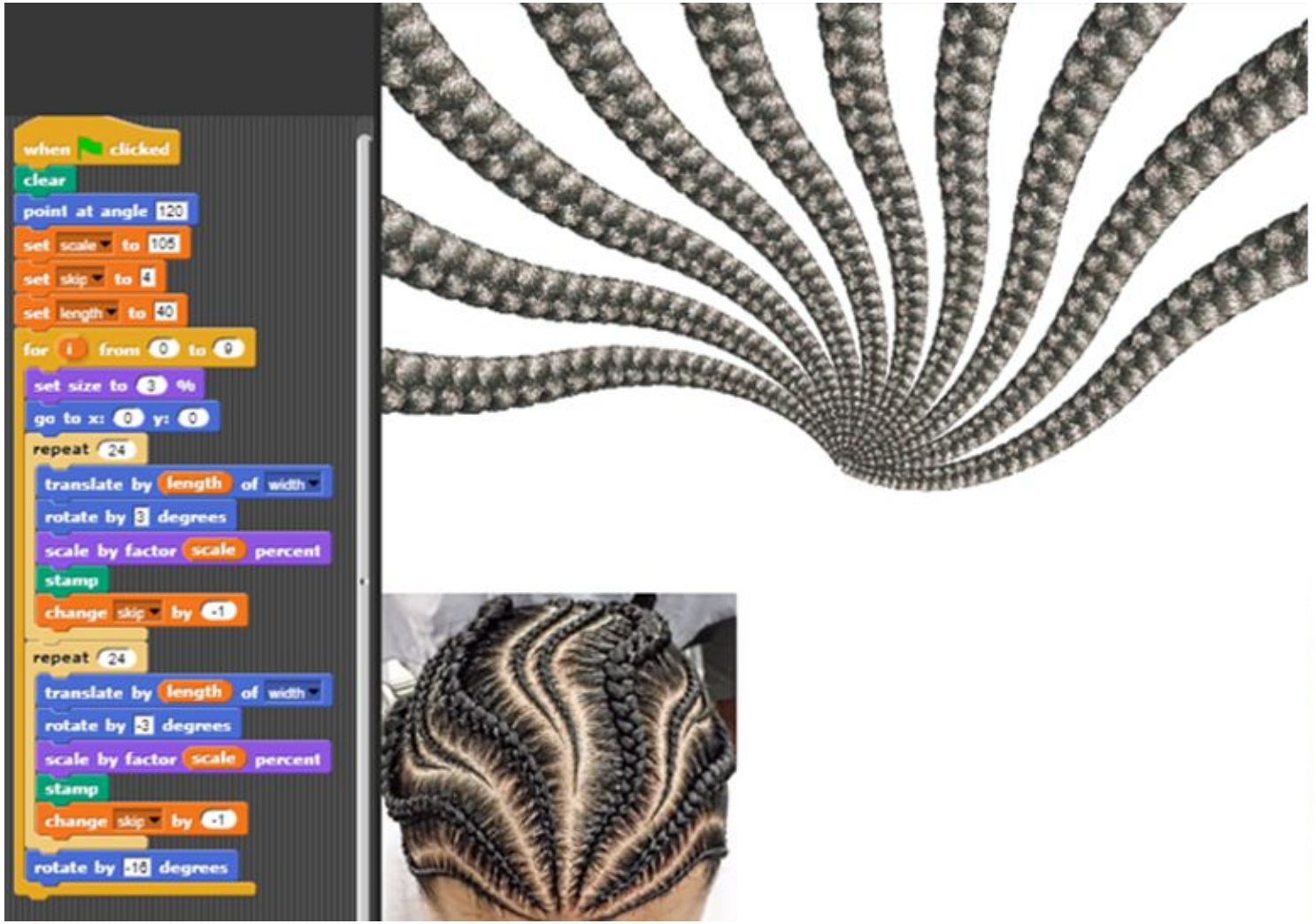


Anishinaabe Arcs



Navajo Weaver

CSDTs allow creative exploration with heritage algorithms



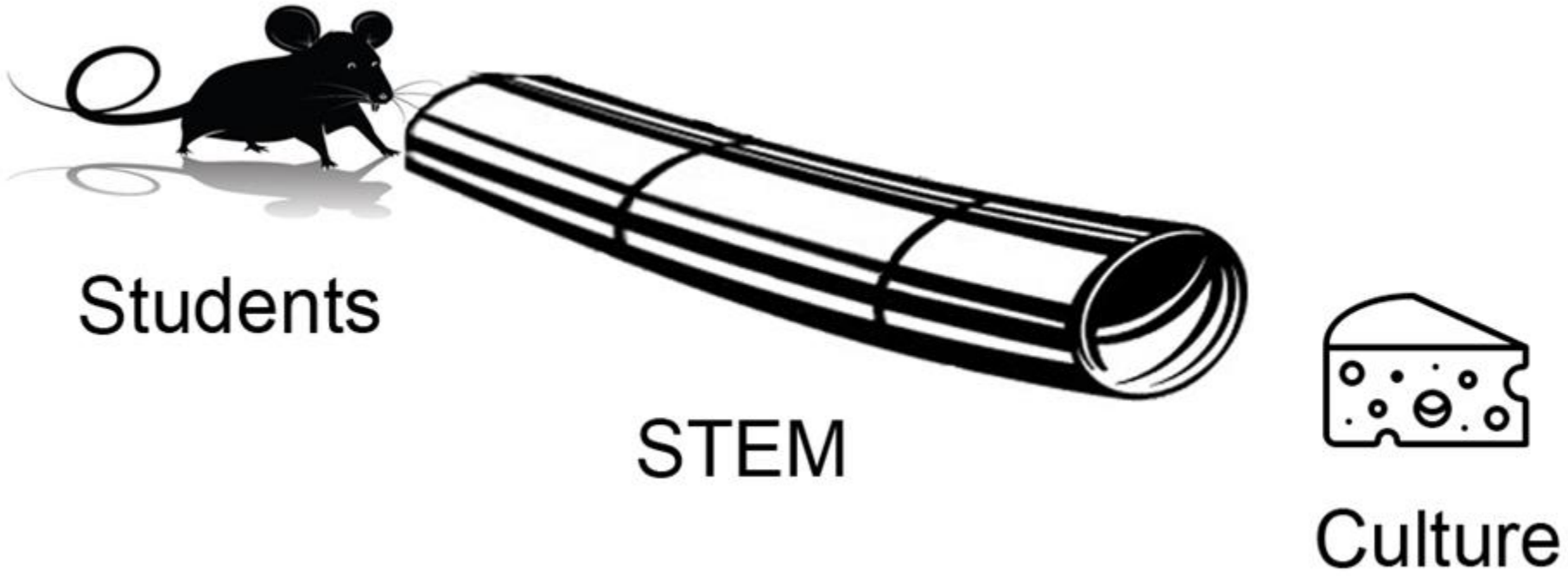
Fractal Simulations of African Design in Pre-College Computing Education

ACM Transactions on Computing Education, Volume 11, Issue 3, Oct 2011

- 10th grade computer science class, two sections.
- About 75% minority, over 50% female.
- Control class has 6 days on fractal instruction websites with java applets.
- Intervention class has 6 days on the African fractals website.

- Post-test shows higher scores in intervention group;
- statistically significant at .001 level

The WRONG way to think about culture-based STEM education



How to bring Indigenous and vernacular knowledge into education without reduction to the service of hegemony?

CSDT development process

1. Work with artisans, elders, others to ensure we have a basis for collaboration and “cultural permission” (not just a matter of copyright!)

2. Interview artisans and research cultural background to understand the knowledge system from their point of view (“emic” not “etic”).

3. Translate their practices and concepts into equivalents in STEM (weaving algorithms, geometric transforms, power law scaling, anti-aliasing, context free grammars, etc.).

4. Embed these concepts in a “design tool” applet that allows students to simulate the original designs and create their own innovations

Audrey interviews Carole Harris on her Detroit jazz-inspired quilts

How to bring Indigenous and vernacular knowledge into education without reduction to the service of hegemony?

CSDT deployment process

1. Students need anti-primitivist cultural, historical background. Examples: graffiti is not just vandalism; cornrows are not just fashion; beadwork is not just decoration.

2. Students need anti-primitivist STEM representations; eg heritage algorithms

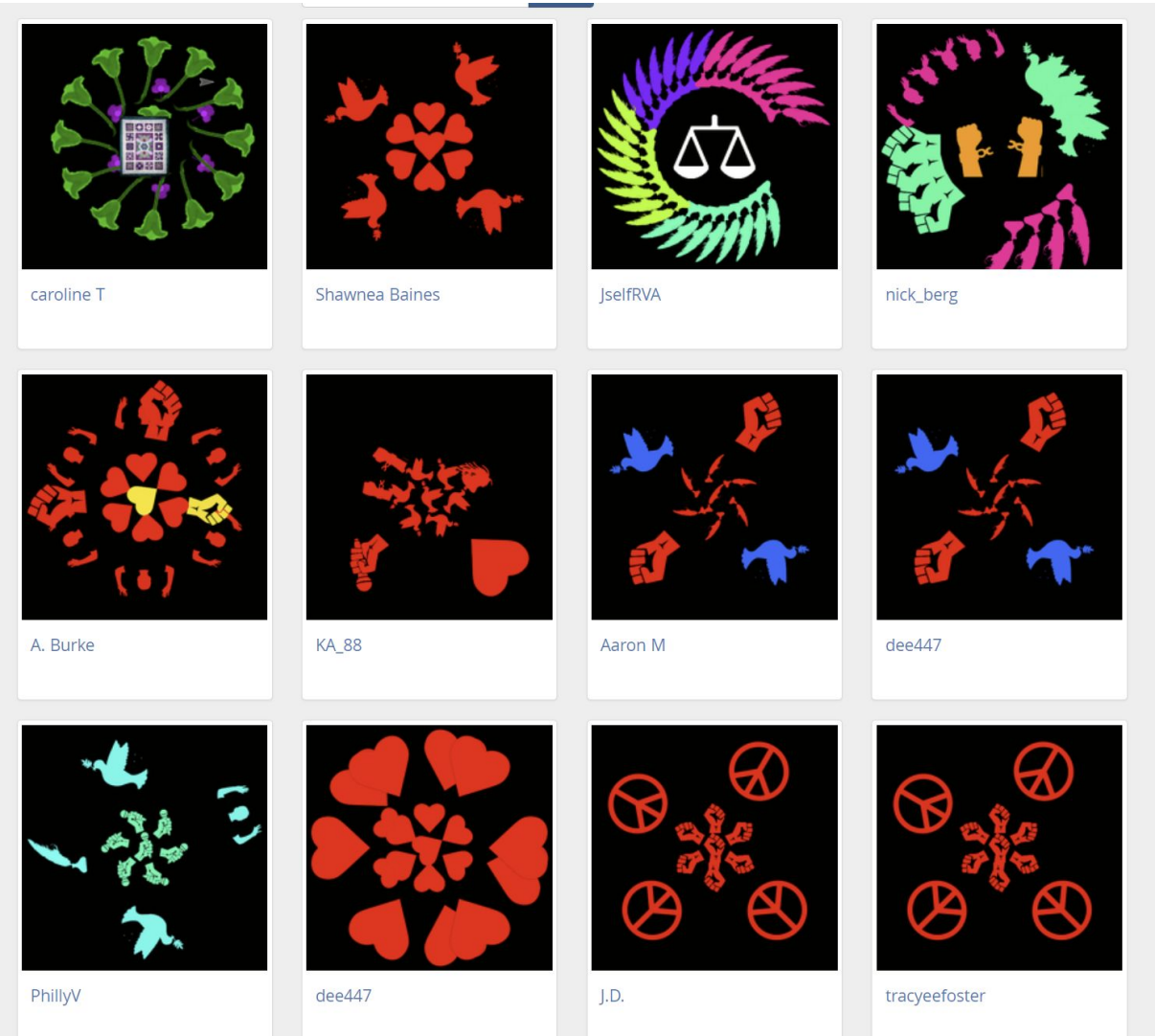
3. Students need anti-essentialist frameworks: the freedom to allow hybridity, exploration, expression, agency.

4. Teachers need the flexibility to make curricular connections that emerge naturally from the intrinsically motivated activities of students

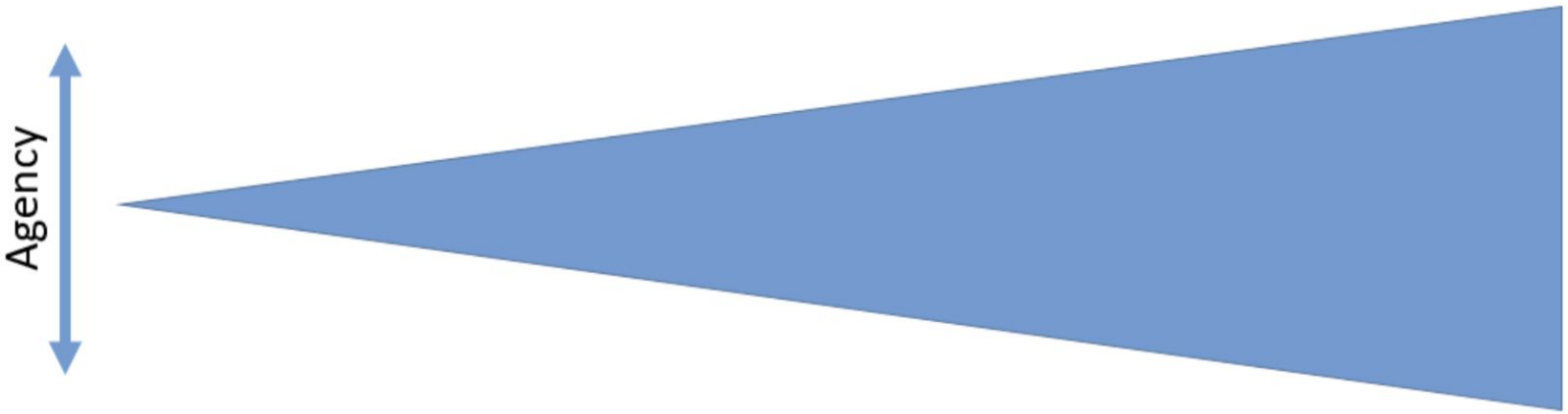
5. Communities need a generation of youth that can see how education contributes to local empowerment.

hybridity, not purity

we start with Indigenous tradition, but leave room for exploration



CSDT pedagogy: the inverted funnel of expanding agency in Generative STEM



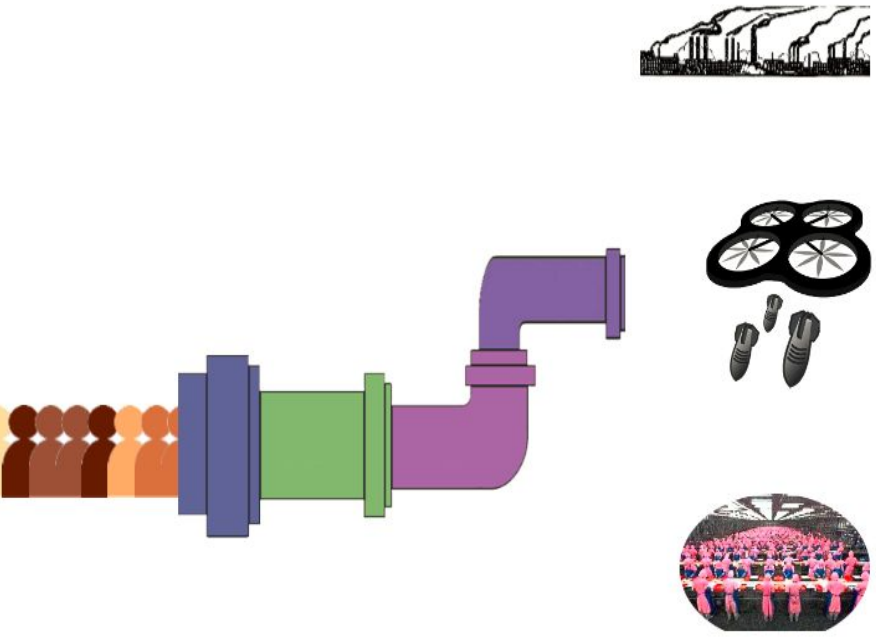
Level 1: simulating original artifact from community

Level 2: creative exploration of heritage algorithms

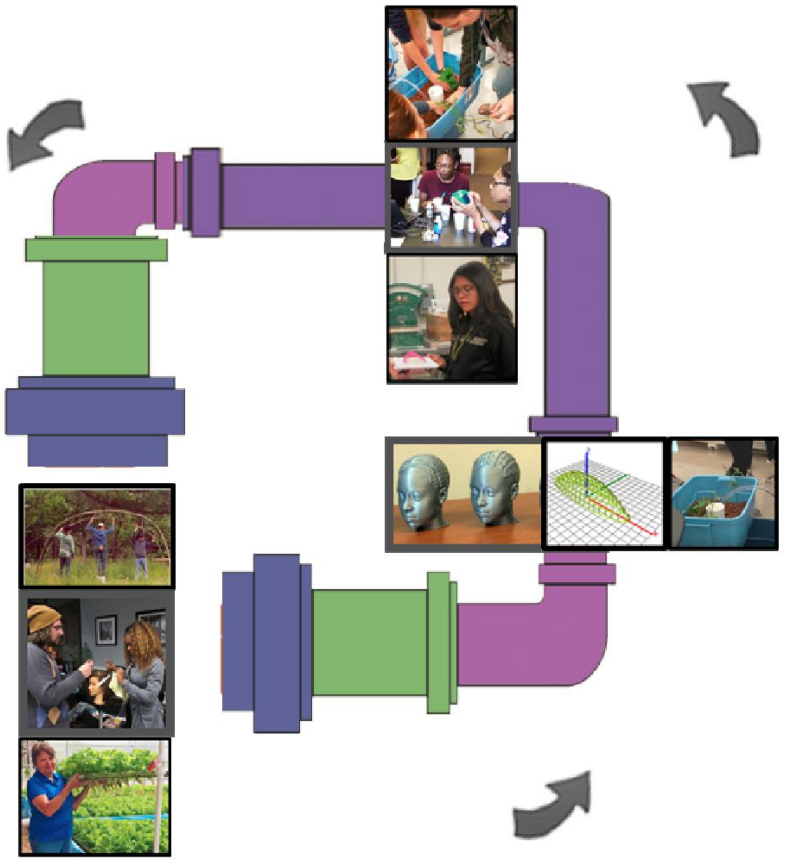
Level 3: Creative physical renders

Level 4: Creative Community contributions

Extractive STEM education

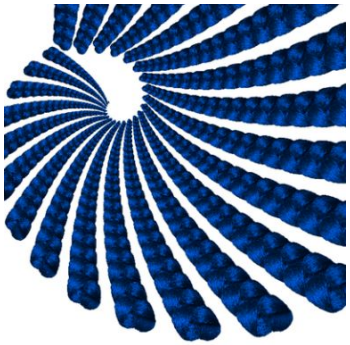


Generative STEM



The Generative Cycle in Albany

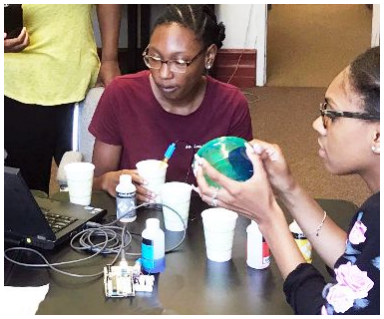
Practical applications benefit braiding shops and inspire more student interest



Cornrows simulations for STEM

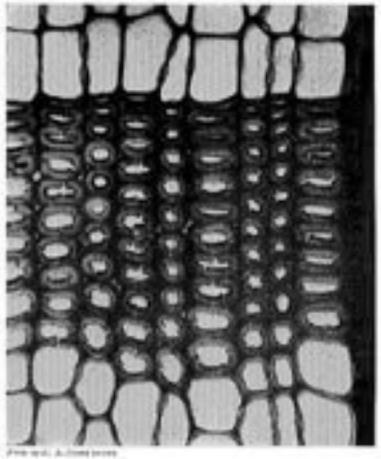
3D printed mannequin heads to increase customers

Development of testing kits for hair product pH

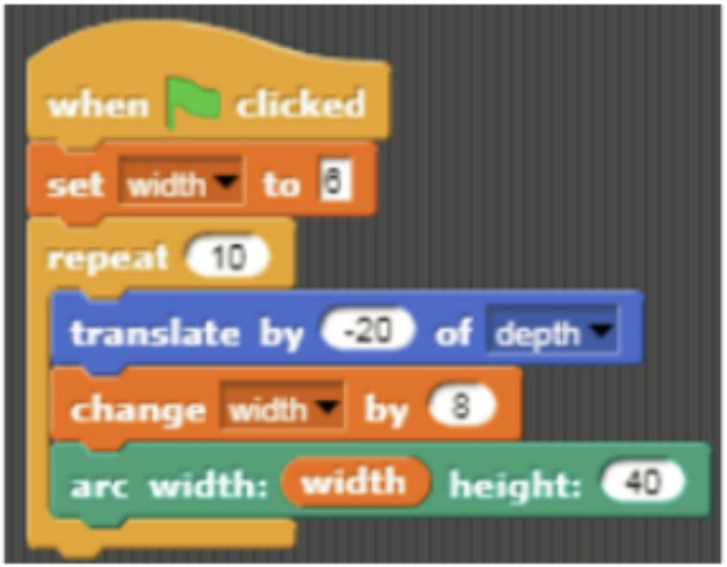


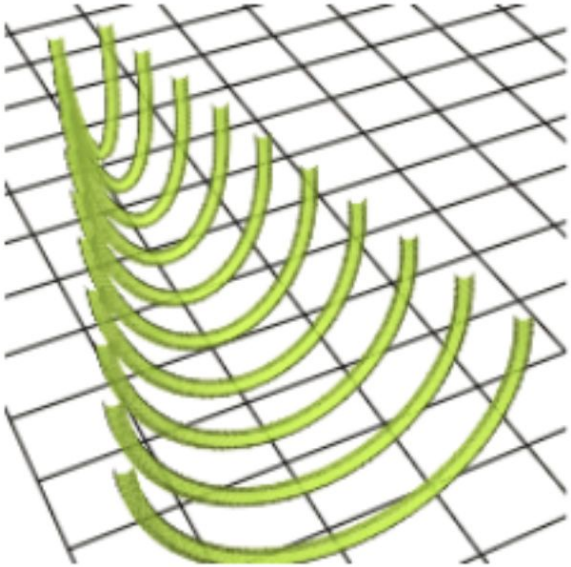
Ecological value flow between humans and non-humans is one Indigenous strategy for preventing extraction

Native american use of arc geometry is a relationship with trees



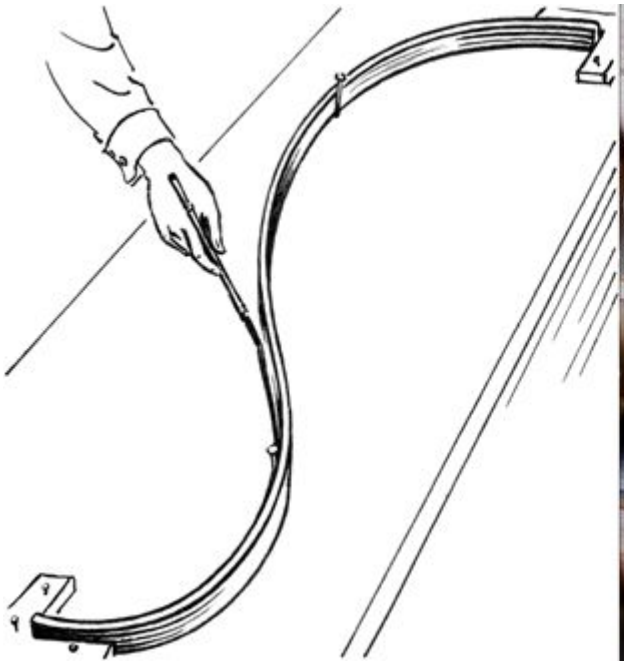
Results from educational workshops





“I believe my design represents the two worlds I come from. One being of my Native heritage and the other of the technology era. With the completion of my structure I was able to combine two worlds and accumulate an interest in engineering... This project has taught me that I can provide and give back for my people while incorporating important traditions and teachings to create a productive environment”

Unalienated value forms are often embodied relations between human and nonhuman collaborators

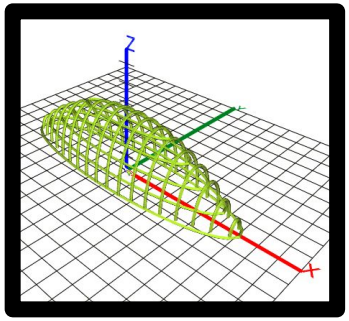


Bézier worked at French automaker Citroën
Wood spline became computer graphics spline

The same curve family created in Anishinaabe tradition

The Generative Cycle in Anishinaabe culture

NMU Center for Native American Studies investigates Indigenous knowledge and practices



Students learn Heritage algorithms

Physical rendering and discovery learning

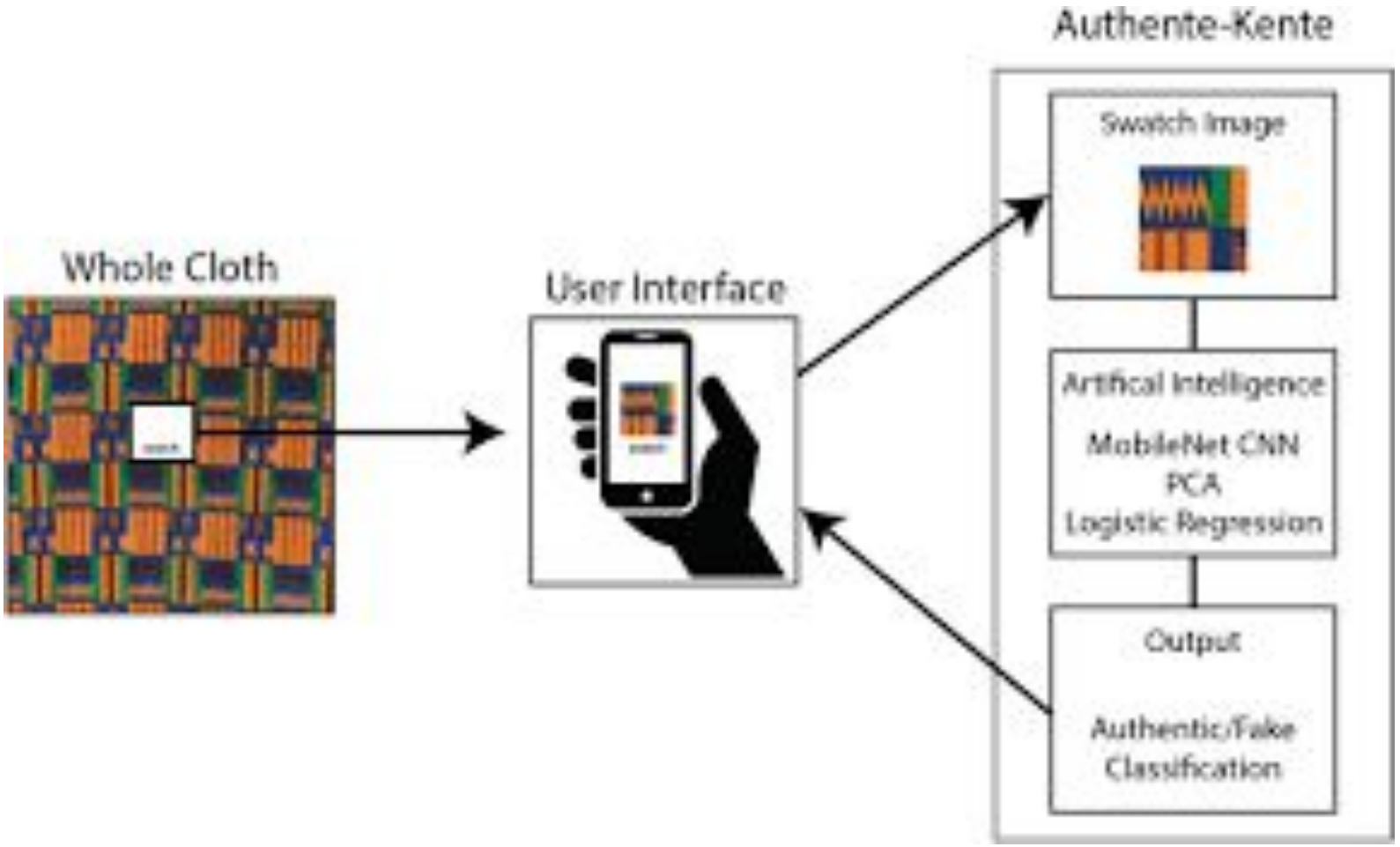
Students develop ideas for how STEM can contribute to indigenous communities

Embodying labor value is another Indigenous strategy for preventing extraction

Generative economy is maximizing the visibility of labor, to ensure ethical flows of value.
Capitalism ensures invisibility by converting value to numbers, masking injustice.

Craft complexity is labor value made visible

AI in Kente Authentication



https://www.researchgate.net/publication/343745338_Authente-Kente_-_Enabling_Authentication_for_Artisanal_Economies_with_Deep_Learning

Putting it to work:

https://africanfuturist.org/

Youth learning STEM through CSDTs; learning digital fabrication in collaboration with elders

Traditional artists working with youth to bring new techniques into their product line.

Inter-generational STEM learning puts Africa's heritage into the future

For more on applications:

https://generativejustice.org/projects/