Did you park in the parking lot? Perhaps our parking lot is a bit too large, considering the number of cars using it.

Sean Lockwood

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Fine Art

University of Washington

2019

Committee:
Ellen Garvens
Rebecca Cummins
Aaron Flint Jamison

Program Authorized to Offer Degree:
Art

University of Washington

Abstract

Did you park in the parking lot? Perhaps our parking lot is a bit too large, considering the number of cars using it.

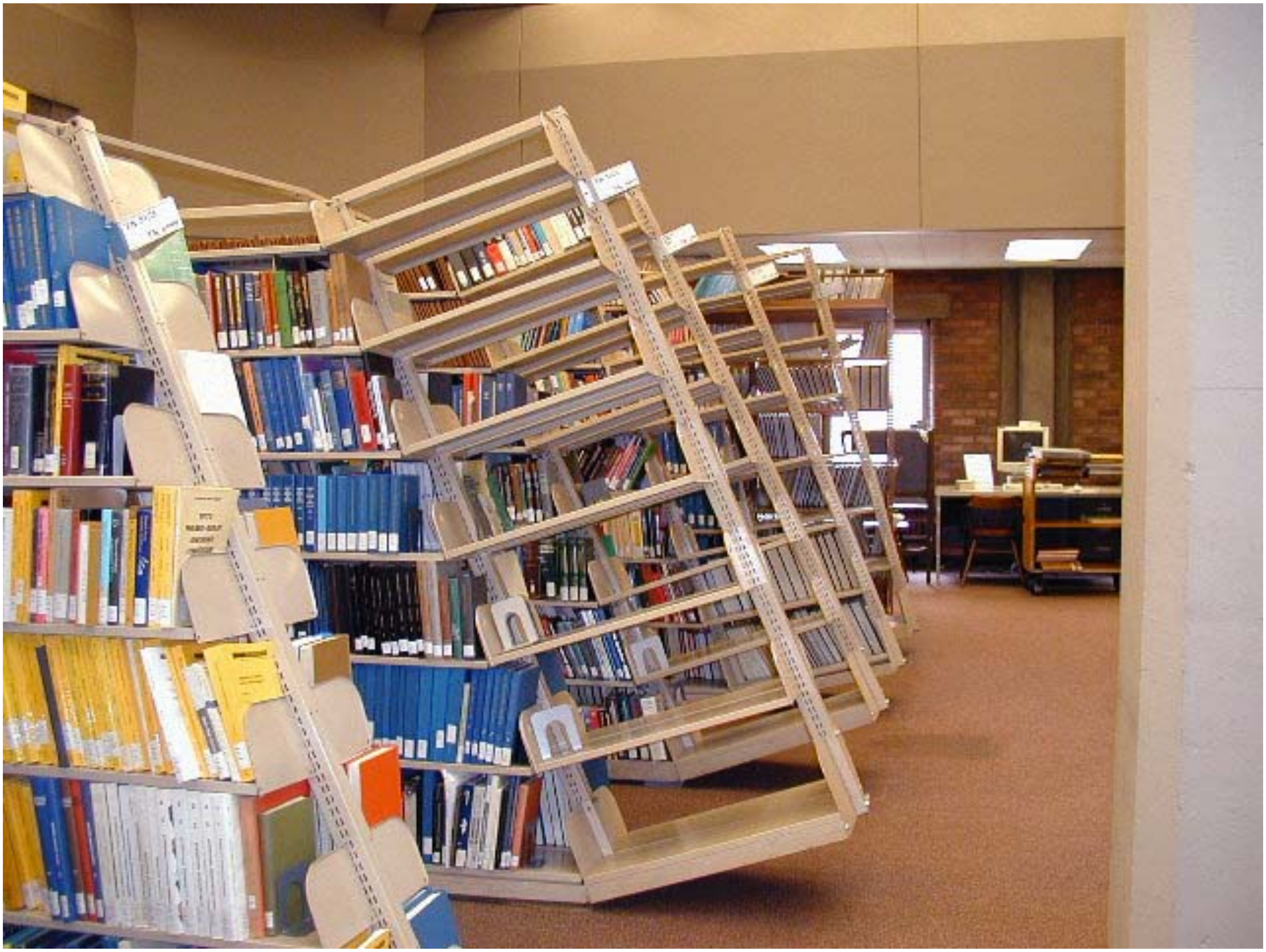
Sean Lockwood

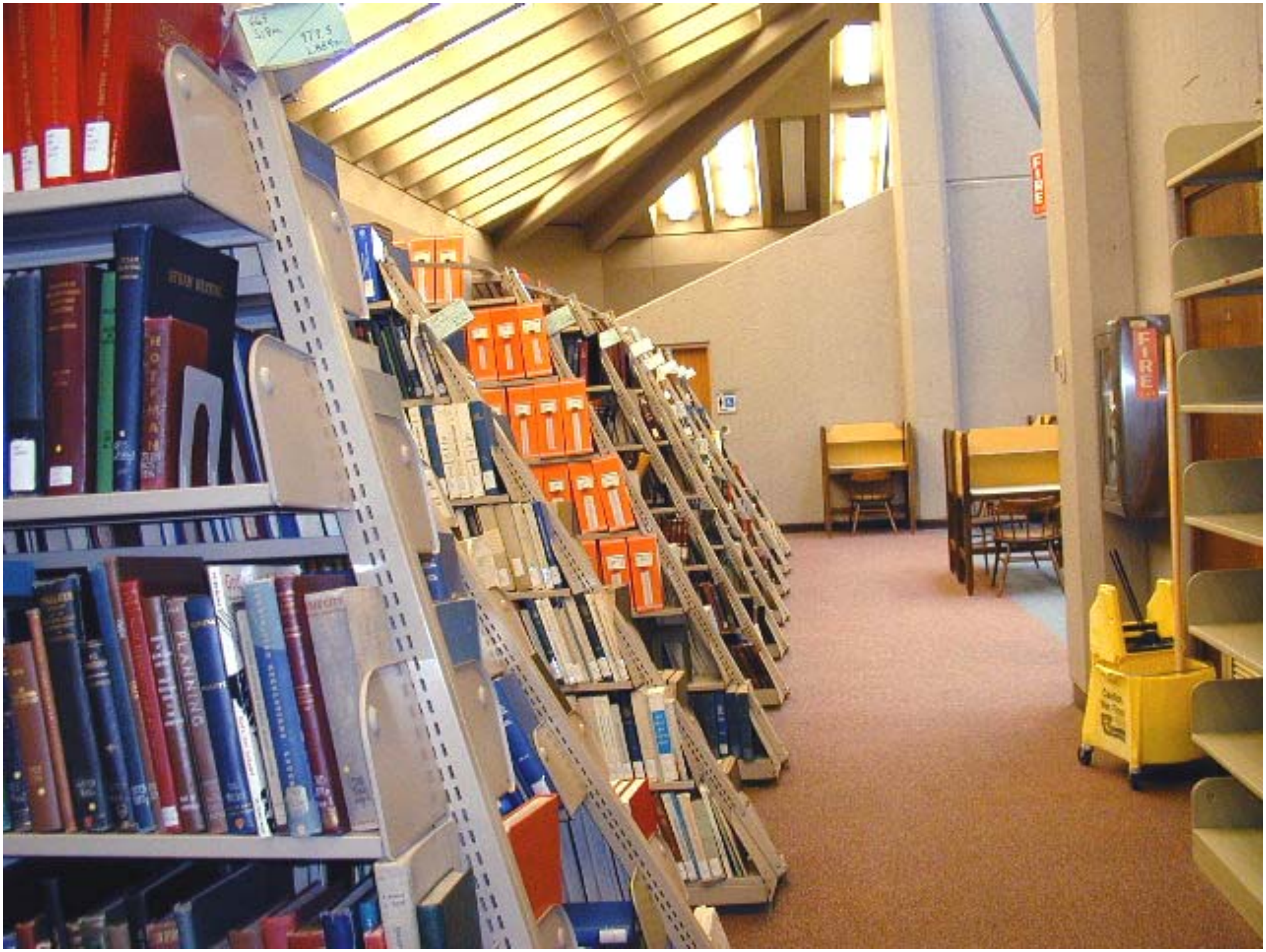
Chair of the Supervisory Committee:
Ellen Garvens
Department of Photomedia

In order to produce an artwork for the Master of Fine Art Thesis Exhibition at the Henry Art Gallery the artist has chosen to consider the institution of the Henry Art Gallery itself and the institution of the University of Washington that provides a greater context for the Henry Art Gallery, as well as the School of Art and the program authorized to offer the degree of Master of Fine Art. Like the artwork displayed in the exhibition, this paper shares a determination of an overall thesis between the two forms of production. In order to produce a written thesis for the requirements of the degree of Master of Fine Art, it is necessary to also consider the institution. Specifically within that focus, the *institution*'s ability to provide examples of its own ability to reflect upon itself, turning inward, and exposing its outer—formerly inner—walls, so that we may be given more insight to the systems that allow for the production-of and experience-of art.


TJ 212
A5
TJ 279
TJ 1075
TK 7


TS 1400
VM 359

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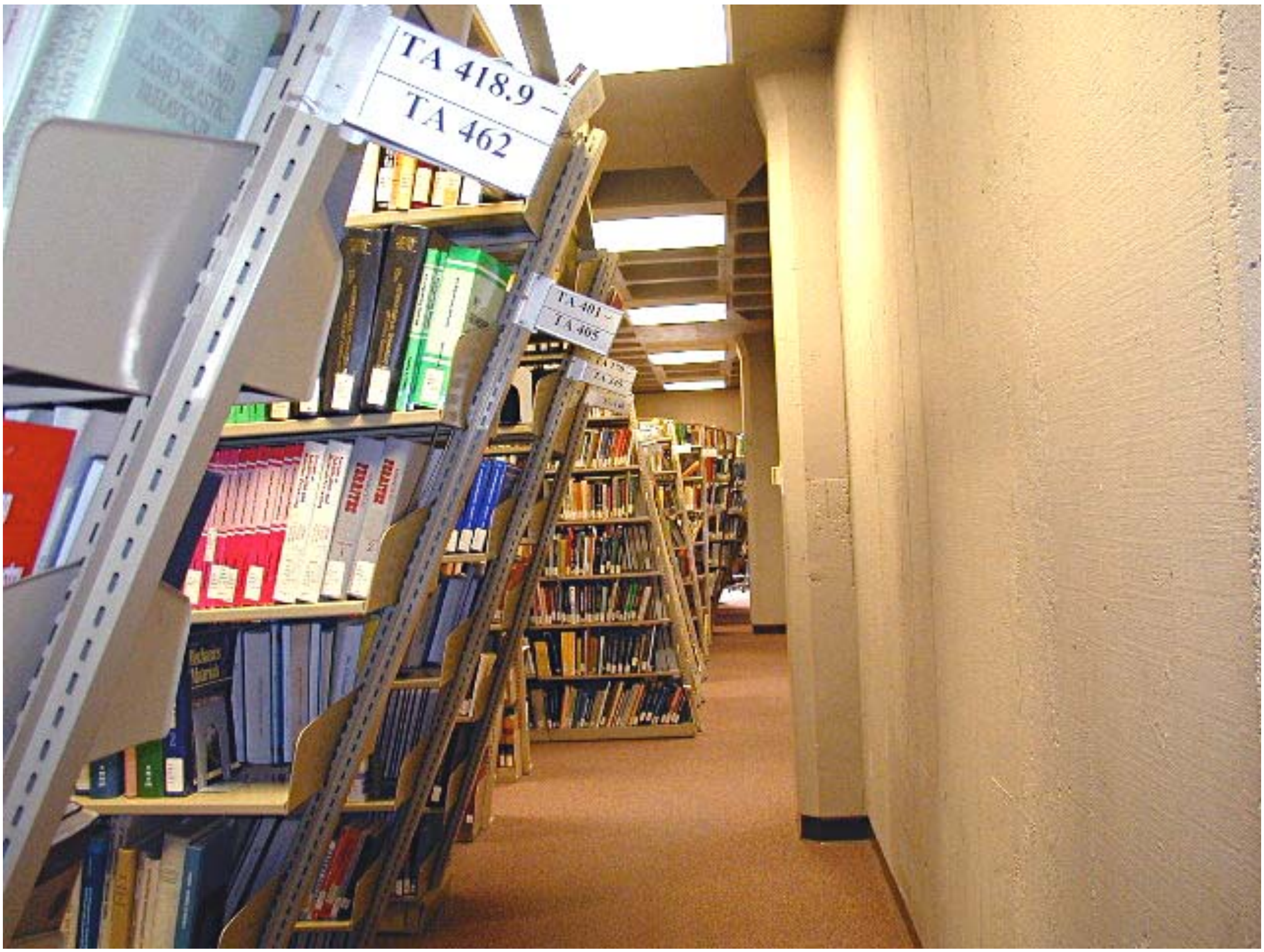
FIRE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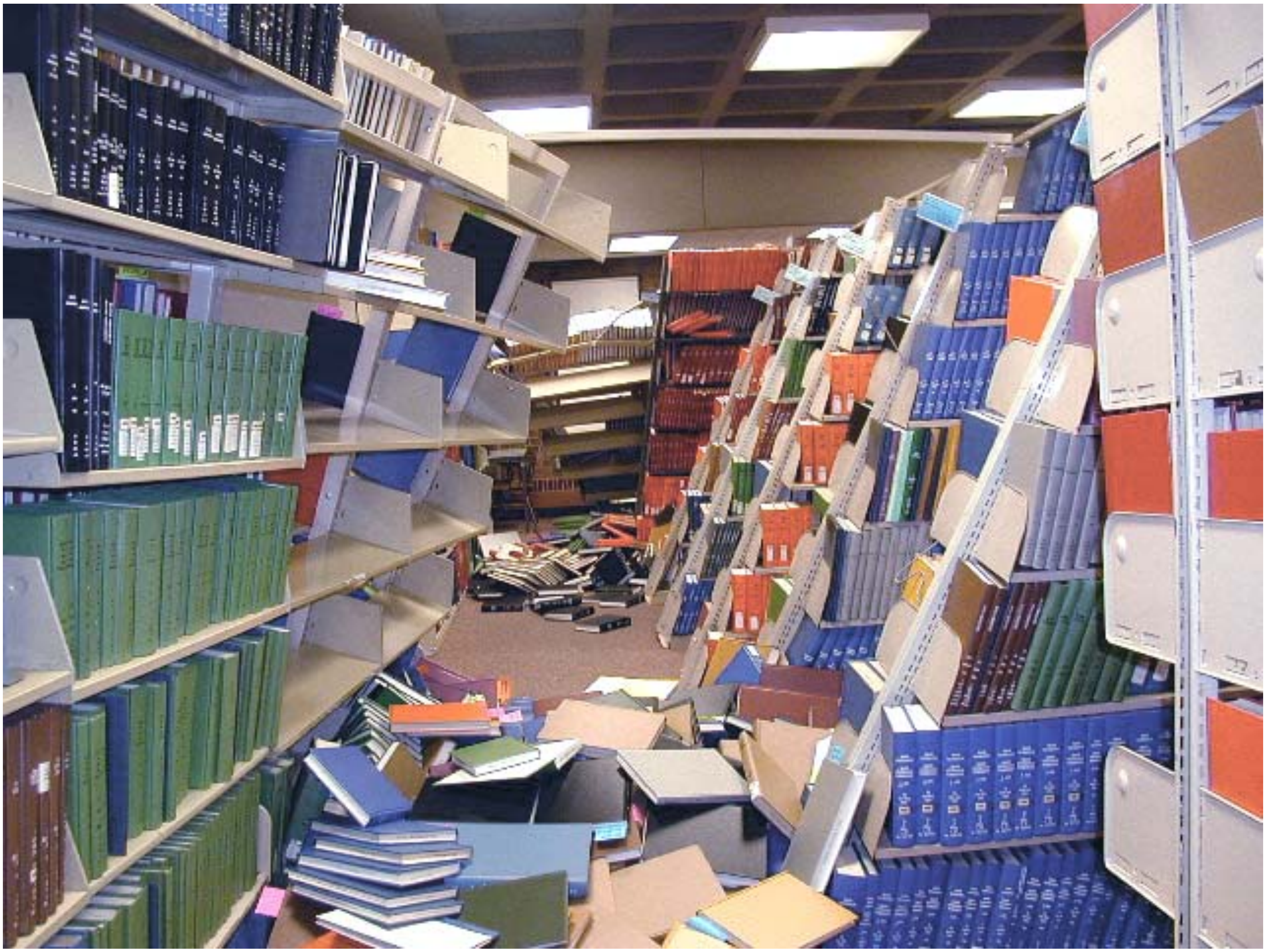


AGARD
Composite Materials

[1]

1 A collection of found photographs showing damages of University libraries in the aftermath of the Nisqually Earthquake. These images are pulled from and hosted on the University of Washington School of Engineering Library website under page titled '*quake*'. Photographer uncredited. posted February 28, 2001 http://www.lib.washington.edu/engineering/images/quake/

Almost two decades ago the Nisqually earthquake occurred at 10:54 a.m. local time on Wednesday 28th February 2001. Its hypocenter lay 30 miles beneath the Nisqually delta area, approximately 11 miles northeast of Olympia WA. The moment magnitude was 6.8. Loss of life due to the earthquake was limited to one person who suffered a heart attack that was attributed to earthquake trauma. Approximately 400 people were injured sufficiently to seek medical assistance. On the day of the earthquake, the state declared a state of emergency. The next day, the Governor requested federal assistance and estimated the economic consequences at $2 billion.[2] With this information in mind we will focus on the images above that are presently available online through the University of Washington's School of Engineering web portal.

Engineering Library	*There was no structural damage to the facility itself, but literally every stack range on the second, third, and fourth floors was damaged by the earthquake.*
Fisheries-Oceanography Library	*The Fisheries- Oceanography Library suffered the same kind of catastrophic stack collapse as the Engineering Library did, but on a smaller scale.*
Suzzallo Library	*There was no structural damage to the building and the 1963 section opened again on March 1, except for the 4th floor where three ranges of stacks collapsed.*
Odegaard Undergraduate Library	*Over 700 books fell from the shelves […]*
Mathematics Research Library	*The Math Research branch library suffered some stack damage during the quake.*
Physics-Astronomy Library	*This library, located on the 5th floor of the new Physics-Astronomy Building, suffered no interruption in service, but approximately 5,000 volumes fell from its stacks.*
Health Sciences Library	*The libraries themselves made it through the quake relatively unscathed, but there were significant safety concerns about the buildings in which they operate.*
Easy Asia Library	*Few books fell in the stacks, but several pieces of decorative trim from the ceiling in the ornate Reading Room broke off.*
Sandpoint Shelving Facility	*The Sand Point Shelving Facility contains approximately 550,000 volumes of important but low-use material. The building suffered no structural or stack damage, but the quake toppled nearly 11,000 volumes.*

3

[2] Ken Creager, Robert Crosson, Thomas Pratt, Craig Weaver, Steven Kramer, Gregory MacRae, Dawn Lehman, Marc Eberhard, Laura Lowes, John Stanton, Don Ballantyne, Peter May, Stephanie Chang, UW, USGS, EQE Engineers, *THE NISQUALLY EARTHQUAKE OF 28 FEBRUARY 2001 PRELIMINARY RECONNAISSANCE REPORT,* Introduction, Earthquake Engineering Research Institute, https://www.eeri.org/lfe/pdf/usa_nisqually_preliminary_report.pdf

[3] Gordon Aamot, *Earthquake!,* Library Directions; a newsletter of the Libraries of the University of Washington, Vol. 11 No. 3 2001, 1-2. Table organized using data retrieved from the article.

Analyzing the photos above we are able to discern a few things and make one firm conclusion. There is a visible pixelation to all of the images. They are low resolution in their quality, a bit grainy, meaning these images are meant to stay on the web (as opposed to being printed). Many of the images use a flash, telling us that the spaces themselves were not light enough to exhibit the damages to the shelves, respectively. The flash also tells us that no additional photographic lighting was brought to the site. It was important to capture the effects of the earthquake as the effects objectively stood.[4] Meaning, the content of these photographs show damages to the stacks of the libraries as immediately as possible after the quake occurred. We then must suppose no human intervention with the piles of books has occurred yet, in these images. These formal deductions of the photos, the year they were taken, and the time span between being taken and their availability for reconnaissance reports make it safe to assume that the photographs were taken with a digital camera.[5]

Images of the damage and fallen books of the University of Washington libraries have an effect. They first instigate a stark reminder of the physical composition of printed matter. Their dimension, shape, and weight are relatively uniform in these images as the volumes' design is meant to emphasize the content and not the outward appearance of the material. They remind us of the vulnerabilities in the systems we choose to manage our information and knowledge; what we decide is worthy to remember and persist. The image of paper on the floor rejects every notion of its purpose. Pages, face down on the floor, deject meaning. Shelves are made for the distinct reason of keeping an object from being on the floor—the ground; nowhere. In order for something to be seen, by our eyes, that are on our head, which are on our bodies, we stack them, and eventually, when something reaches the right height, the stress produced on our neck, the connection from our brain to body, is under a condition of increasingly less stress, and we do not have to look down to see it.

However this effect is likely not the effect intended by the School of Engineering's decision to keep these images available in their online repository. One would more likely make the connection between the photos of structural-failure and locate them within their context of the entire division of the school dedicated to *Engineering*. They are *reference* images. The images themselves are referencing the structural-failure of storing reference-material. Perhaps then the images' presence on the site functions to instigate an action in addition to preserving a memory. In the same way the libraries of the university exist to preserve the memory and experience of thought, these images serve this function to enforce the need and drive to build and archives.

Removing the threat of intention from the scenario the two stated effects have overlap on one characteristic importance of the content of the images. They are illustrative of a structural support system. Although the photographs seem to focus on the piles of books on the ground in many cases, others are more able to depict and reveal the shelves or "stacks" as the real subject of the photos. It is possible to recognize this specific structural support as an object and observe it in relation to other systems of structural support. The connection between the structural support of a library and the content of the books is as stated previously, a very immediate and physically implemented one.

In order to illustrate how the comparison and connection can be made between structural support systems of archived experience, one can imagine an architecture that has been integrated in our current reference systems. Despite seeming more immaterial electronic media reference systems also rely on structural support systems in the form of 'cable-management' in order to more or less hide the infrastructure of the system, denoting it as 'messy' or hazardous.

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[4] Or *fell*, rather.

[5] One month after the Nisqually Earthquake, Digital Photography Review reports on the rapid penetration of digital cameras into the households of the US. "*Digital camera penetration doubled in 2000 to reach 25% of US Internet households, and consumer purchase plans indicate that it will double again in 2001, according to a new survey of over 1,000 US Internet households by InfoTrends Research Group, Inc.*" dpreview staff, March 12, 2001, accessed at https://www.dpreview.com/articles/5944950863/doubledigimarket. Compared to "US internet households" the university is likely to have the same if not more immediate access to digital photography.

We see napkins today as disposable—often paper products—that can make small messes quickly disappear. They also rid our fingers of the bits of grease or salt after eating something. Sometimes, though, in restaurants the napkin is made of fabric, suggesting more wherewithal against greater deposits of finger matter. When we encounter the napkin in this context, we encounter it waiting for us, at a place at the table, in some configuration. The waitstaff of the establishment has prepared it there. It may be rolled into a tightly fitting wrap around the silverware, or it might be folded several times —in either case, holding an appearance that is immediately destroyed when the guest sits down, and places it on their lap.

The Napkin Folding Problem, or The Margulis Napkin Problem

In mathematics there is a geometry problem called the Napkin Folding Problem. It asks whether it is possible to fold a square napkin in such a way that the overall perimeter of the napkin is increased. If a quadratic plane's perimeter can be thought of in any case as a sum total of *4*, then the idea would be to achieve a higher sum than 4 by folding the plane. The problem is also referred to as the Margulis napkin problem, after the mathematician Grigory Margulis. One normally imagines folding of material to be subtracting material, not adding to it, and the result will be a reduction of space the material occupies. The problem is famous because it explores this seemingly paradoxical idea, and many have put forth proposals for folding the plane that will break the readily available conception of folding we have.

"Where Only The Result Matters"

A thread of emails between professors of mathematics at different universities around the world between February 1996 and April 1997 is archived[6] on the personal website of University of California Irvine Computer Science professor David Eppstein.[7] Scrolling through the long chain of emails brings certain truths to light. There are many possible solutions offered and disputed based on making the napkin bigger despite its physical limitations. Some solutions remain rigid in their approach to maintain physical rules, but others venture into positing alternative instances of the napkin's existence where its physical limitations were actually different. The discussion turns to origami eventually, as Origami exists today as a kind of umbrella term for any kind of folding production. Origami art however is a very relevant example of an art form based on adding dimension to flat pieces of paper. This idea is simply that when a piece of paper is folded, it is no longer flat, and even if you try to press the two new sides along the fold against each other with as much force as possible, there will still be space between them, and the added dimension of the paper that is folded. This material does not simply disappear despite dividing the space. Origami also generally utilizes three dimensional forms made from 'two dimensional' materials.[8]

From:	propp@math.mit.edu (Jim Propp)
Date:	14 Feb 1996 01:51:48 -0500
Newsgroups:	sci.math.research
Subject:	The Margulis Napkin Problem

```
The Margulis Napkin Problem asks one to prove that it is impossible to
fold a unit square to form a flat shape who perimeter is greater than 4.

Rumor has it that all Russian graduate students of mathematics know how
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[6] *The Margulis Napkin Problem*, https://www.ics.uci.edu/~eppstein/junkyard/napkin.html, "Jim Propp asked for a proof that the perimeter of a flat origami figure must be at most that of the original starting square. Gregory Sorkin provides a simple example showing that on the contrary, the perimeter can be arbitrarily large". The article also comes from the "Math Fun" section of the personal website. In another section of the personal website David exhibits his photography as he considers it a hobby.

[7] *About*, https://www.ics.uci.edu/~eppstein/

[8] This is not to say that pieces of paper, or the starting material that is used for an origami folding does not have physical dimension in the x, y, z axis. Paper, and in the previous example, napkins, simply represent a metaphorical example of 'flatness' because they are square, and because they occupy very little 'z' dimension as to make this actual measurement negligible, and the real-life example object can simultaneously function as a metaphorical and physical object.

to solve this Problem, but that as soon as they come to the U.S. (as so many of them seem to do!), they forget how it's done.

Can anyone offer a rigorous proof?

Jim Propp
Department of Mathematics
M.I.T.

From: Einar Andreas Rodland <einara@math.uio.no>
Newsgroups: sci.math
Subject: Max circumference of folded paper (solution)
Date: Tue, 20 Feb 1996 21:30:53 +0100
Organization: University of Oslo

Someone posted the following question some time ago:

If you have a quadratic piece of paper and fold it a number of times, prove that the circumference cannot exceed 4 (the original circumference).

I couldn't find the original posting, hence, I quote the Problem as I remember it.

==

SOLUTION:

If you have a piece of paper with any shape, I wish to prove that when folding it, the circumference will be reduced. Say that you fold it along a line AB where A and B are the endpoints, and where the line AB is included in the paper before folding. (If there is a hole in the paper or the paper is non-convex, AB may pass over a region which is not included in AB. We will deal with this later.)

Now, AB is included in the paper. When folding along AB, the circumference is increase by AB due to the folding. The two components of the paper each have circumference that go from A to B: ie. you may follow the circumference of any component from A to B. When folding this, you get a new circumference: the outermost of these. We may however follow the part of the original circumference that falls inside the folded paper. This, too, gives a curve from A to B and must therefore have length at least AB. Hence, though we gain AB, we loose more than AB.

If the line AB is not fully contained in the paper, you may let the intersections between AB and the circumference of the original paper by P_1, ..., P_2n (n components of AB). The 'inner cricumferences' as were constructed above will arise here to, but will connect pairs of points P_i (not neccesarily neighboring points).

The conclusion follows as above.

Einar

--
Einar Andreas Rodland E-mail: einara@math.uio.no
University of Oslo, Norway
Departement of Mathematics http://www.math.uio.no/~einara

From: Danny Calegari <dannyc@math.berkeley.edu>
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: Sat, 02 Mar 1996 04:11:16 -0800
Organization: UC Berkeley

Einar Andreas Rodland wrote:

> . . (preamble excised)
>
> SOLUTION:
>
> If you have a piece of paper with ANY shape, I wish to prove that
> when folding it, the circumference will be reduced. Say that you
> fold it along a line AB where A and B are the endpoints, and where
> the line AB is included in the paper before folding.
>
> . . (rest of solution excised)
>

I think the point of the MNP was that what is folded repeatedly is the original square, not the image of the square at each stage. Certainly the first fold decreases the circumference, but subsequent folds may "unfold" bits that have been folded in, possibly in some strange way. The "foldings" at each stage are locally isometric maps of the square into R^2, and the "circumference" at each stage is the circ. of the image. But it is the square that is folded at each stage (like an origami construction), not its image.

Is the Problem known to be true then? (as J. Propp's post suggests)

Danny Calegari.

From: lepro@math.wisc.edu (Douglas R Lepro)
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: 2 Mar 1996 19:18:33 GMT
Organization: University of Wisconsin, Madison
Summary: not proved yet

Einar Andreas Rodland <einara@math.uio.no> wrote:
>Jim Propp wrote:
>> The Margulis Napkin Problem asks one to prove that it is impossible to
>> fold a unit square to form a flat shape who perimeter is greater than 4.
... (deletia)
>> Jim Propp
>
>SOLUTION:
>If you have a piece of paper with ANY shape, I wish to prove that
>when folding it, the circumference will be reduced. Say that you
>
...(proof that any fold of single thickness shape reduces circumference)
>
>Hence, folding any shape once reduces the circumference. Then, of
>course, repeated folding will reduce the circumference.
>--
>Einar Andreas Rodland   E-mail: einara@math.uio.no
>

The above is not a full solution. If your paper likes to stick to itself so much that after any fold you may again consider yourself to have only a single thickness of paper, the above argument works as advertised. However, even the most trivial of origami folds (including a mountain fold somewhere, for example) requires that the paper be partially unfolded at some point. Not all flat folded shapes are achievable from simple folds of the type outlined above. Now, if someone wants to show that the *shadow* of any flat folded figure is achievable with the shadow of a figure including only simple folds, the above is the required final step. However, I don't believe that part about shadow achievability. :-)
I think a proof would have to consider an arbitrarily folded flat figure and the prover should be careful with any inductions used.
Doug -- lepro@math.wisc.edu
--
Douglas R. Lepro
lepro@math.wisc.edu

From: greg@math.uiuc.edu (Greg Kuperberg)
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: 2 Mar 1996 20:46:03 GMT
Organization: Yale department of mathematics

In article <3136FB25.4F107A44@math.uio.no> Einar Andreas Rodland
<einara@math.uio.no> writes:
>> The Margulis Napkin Problem asks one to prove that it is impossible to
>> fold a unit square to form a flat shape who perimeter is greater than 4.
...
>Hence, folding any shape once reduces the circumference.

Yes, this is not too hard.

>Then, of course, repeated folding will reduce the circumference.

This reasoning doesn't work with the intended terms of the question. If by "fold" you mean a composition of maps (x,y) -> (|x|,y), then yes. But in the more usual sense of folding, the perimeter can go back up when you make a second fold:

```
            _______
           /.      |
          / .      |
      ___/...      |
     |  /  .       |
     | /  .        |
     |/  .         |
     /  .          |
    /. .           |
   / ..            |
  /...             |
  |                |
  |________________|
```

So a reasonable rigorous interpretation of the question is: If f is a continuous piecewise isometry from the square [0,1]^2 to the plane R^2, is the perimeter of f([0,1]^2) not more than 4, with equality only for isometries?

Also, I'd like to know about a generalization: Does there exist a shape of napkin the can be folded so that its perimeter goes up?

From: propp@math.mit.edu (Jim Propp)
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: 3 Mar 1996 19:43:07 -0500
Organization: MIT Department of Mathematics

>The Margulis Napkin Problem asks whether it is possible to fold a unit
>square to form a flat shape whose perimeter is greater than 4.

Several people have submitted incorrect solutions that neglect the fact that parts of the paper that disappear from view can reappear when a subsequent folding takes place.

For instance, take a piece of paper and draw two horizontal lines, 4/9 and 5/9 of the way down the page. Make a mountain fold along one line. Now make a valley fold along the other line.

The upshot is that the perimeter need not be a decreasing function of time, so simple proofs-by-induction like the one recently posted here will not suffice.

Jim Propp

From: Einar Andreas Rodland <einara@math.uio.no>
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: Mon, 04 Mar 1996 14:15:19 +0100
Organization: University of Oslo

Einar Andreas Rodland wrote:
>
> Jim Propp wrote:
> >
> > The Margulis Napkin Problem asks one to prove that it is impossible to
> > fold a unit square to form a flat shape who perimeter is greater than 4.
:
>
> SOLUTION:
>
> If you have a piece of paper with ANY shape, I wish to prove that
> when folding it, the circumference will be reduced. Say that you
> fold it along a line AB where A and B are the endpoints, and where
> the line AB is included in the paper before folding. (If there is
> a hole in the paper or the paper is non-convex, AB may pass over a
> region which is not included in AB. We will deal with this later.)
>
:

It has been pointed out to me by several that my proof only covers a group of special cases: foldings that may be described by a line segment and where the paper is folded along that segment. There are several foldings that may not be described this way, in particular cases where only the upmost sheet of paper is folded.

I cannot see any way of fixing the proof.

So to conclude, I am (we are?) back in the wilderness again. :-)

Einar

--
Einar Andreas Rodland E-mail: einara@math.uio.no
University of Oslo, Norway
Departement of Mathematics http://www.math.uio.no/~einara

From: Thomas Mautsch <mautsch@mathematik.hu-berlin.de>
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: Mon, 04 Mar 1996 17:08:07 +0100

Organization: Humboldt Universitaet zu Berlin

Einar Andreas Rodland wrote:
>
> Jim Propp wrote:
> >
> > The Margulis Napkin Problem asks one to prove that it is impossible to
> > fold a unit square to form a flat shape who perimeter is greater than 4.
> >
...
>
> SOLUTION:
>
> If you have a piece of paper with ANY shape, I wish to prove that
> when folding it, the circumference will be reduced.
...

This statement cannot be right because, if you folded the result of your folding back into the original state, you would get the piece of paper you started with but this time with smaller circumference (perimeter?). Contradiction.

However, I would like to see a proper solution myself.

Sorry for the inconvenience
Tom
--

Thomas Mautsch mautsch@mathematik.hu-berlin.de

From: hoey@aic.nrl.navy.mil (Dan Hoey)
Newsgroups: sci.math.research
Subject: Re: The Margulis Napkin Problem
Date: 05 Mar 1996 03:14:31 GMT
Organization: Navy Center for Artificial Intelligence

propp@math.mit.edu (Jim Propp) writes:

> >The Margulis Napkin Problem asks whether it is possible to fold a
> >unit square to form a flat shape whose perimeter is greater than 4.

> Several people have submitted incorrect solutions that neglect the
> fact that parts of the paper that disappear from view can reappear
> when a subsequent folding takes place....

Quite so, but it is not even that simple--your mention of a "subsequent folding" suggests an intention to apply one folding at a time to the napkin. But I doubt that every locally isometric map is achievable by a discrete sequence of simple foldings, even when we allow both folding parts together and unfolding previously folded sections.

As a candidate for this complication, I offer a shape that I hope will _not_ become known as "Hoey's hankie". Form a radiating fan-fold with apex A whose circumference BCDEFG has repeated z-shaped overlaps.

```
 B +---------+_ A
    \       '|\-_
     \      '|`\ -_
      \    ' | `\  -_
       \   ' | ` \   -_
        \ '  |  ` \    -_
         \'  |  `  \     -_
         |\  |   `  \      -_
         | \ |   `   \       -_
        |   \|    `   \        -_
        |   _+    `    \         -_
       |  _-   C   `    \         _+  G
       |_-         `     \      _-
      +-------------------+ E _-
    D               |    /  _-
                     |  / _-
                     | /_-
                      +
                    F
```

The perimeter angle BAG should be Pi - 2(DAC + FAE) so that BAG is a straight line when the fans are unfolded. Create a duplicate fanfold with circumference GHJKLB connected to the original along BAG. As shown, this would unfold into some kind of decagonal shape BCDEFGHJKL with internal point A, but it can be trimmed to form a square enclosing A.

I'm pretty sure you can't fold this one fold at a time.

For another complication, consider that this example can be constructed by manipulations in three-space, using inelastic piecewise flat paper with a finite number of fold lines. But I don't see any reason why the existence of such a construction is guaranteed in general. Could there be a shape that you could not form without temporarily bending the paper into a curve? Could there be one that requires stretching or cutting and pasting?

I don't know if these complications lead us toward counterexamples to the original conjecture. They do make the attempts at proofs by "inductive construction" more dubious, though.

Dan Hoey
Hoey@AIC.NRL.Navy.Mil

This article was e-mailed and also submitted for sci.math.research.

To: eppstein@ics.uci.edu
Subject: Margulis napkin problem
Date: Tue, 12 May 98 19:33:31 -0400
From: "Gregory B. Sorkin" <sorkin@watson.ibm.com>

Dear David,

Just browsed through your geometry junkyard, whose Margulis napkin problem page leaves the impression that the proposition is true, if not quite proved. As your mathematical origami page points out, it's false, and you might want to give a hint of that in the other page (or throw it out entirely?).

Furthermore, it seems that arbitrarily large perimeter is possible. Maybe you already know this, but, imagining a silk handkerchief rather than paper, rule it into an nxn grid, and gather the perimeter of each little square into a point. If you can do this, you have n^2 pillae each of height O(1/n), and sharing a common point as a base; splaying them out to all sides gives perimeter O(n). It seems I was not the first to realize this, and I am assured by Robert Lang that the folding is indeed feasible, and that this is proved by various papers here and there, albeit not all in one place.

-Greg

Date: Wed, 11 Oct 2000 23:00:10 -0400
From: Lars Huttar <lars_huttar@sil.org>
To: eppstein@ics.uci.edu
Subject: suggested additions to your page on the Margulis napkin p...

Subject:
suggested additions to your page on the Margulis napkin problem
----

Hello,

For a more complete explanation of how the Margulis napkin problem is solved, you might want to add the following exchange to your web page. I got the following from http://origami.kvi.nl/archives/a0028x/arc00282.txt (without permission of the authors).

Date: Fri, 11 Apr 1997 00:54:27 -0300 (ADT)
From: Rjlang@aol.com
Subject: Re: [propp@math.mit.edu: Margulis napkin problem]

Jeannine Mosely forwarded to origami-L a query from Jim Propp:

>>>>
Has anyone heard of the "Margulis napkin problem"? (I don't know whether it is indeed due to Margulis.)

This innocuous-sounding puzzle merely asks whether it is possible to fold a square piece of paper (no tearing allowed!) so that the resulting flat figure has larger perimeter than the original square did. Can anyone find a proof that it can't be done?

<<<<

and Mark Casida suggested:

>>>>
Must the folded figure be convex? Or can it be e.g. star shaped? [What if I take an origami sea urchin and (shudder) press it flat on the table? Won't that have a very large perimeter?]
<<<<

which is exactly the right strategy. Not only can you make the perimeter of the star-shaped base larger than the original square; you can make it arbitrarily large. If you fold an order-N Sea Urchin (from Origami Sea Life), it has N^2 points, each of length (1/(2(N-1))). If you make the points arbitrarily thin (using lots and lots of sink folds!), when you flatten it, you'll get a total perimeter of N^2/(N-1), which is unbounded as N is large.

You don't have to go to this extreme, however. If you thin the points of a Bird Base, you can splay the points out into a shape with a perimeter greater than a square. The trick in either case is to create one or more middle points.

Robert J. Lang
rjlang@aol.com

Date: Fri, 11 Apr 1997 11:55:20 -0300 (ADT)
From: Jeannine Mosely <j9@concentra.com>
Subject: Re: [propp@math.mit.edu: Margulis napkin problem]

Robert Lang wrote:

Jeannine Mosely forwarded to origami-L a query from Jim Propp:

>>>>
Has anyone heard of the "Margulis napkin problem"? (I don't know whether it is indeed due to Margulis.)

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Must the folded figure be convex? Or can it be e.g. star shaped? [What if I take an origami sea urchin and (shudder) press it flat on the table? Won't that have a very large perimeter?]

<<<<

which is exactly the right strategy. Not only can you make the perimeter of the star-shaped base larger than the original square; you can make it arbitrarily large. If you fold an order-N Sea Urchin (from Origami Sea Life), it has N^2 points, each of length (1/(2(N-1))). If you make the points arbitrarily thin (using lots and lots of sink folds!), when you flatten it, you'll get a total perimeter of N^2/(N-1), which is unbounded as N is large.

You don't have to go to this extreme, however. If you thin the points of a Bird Base, you can splay the points out into a shape with a perimeter greater than a square. The trick in either case is to create one or more middle points.

Not so fast, Robert! When you flatten the sea Urchin, portions of each point overlap neighboring points, reducing the total perimeter. And I can't get the bird base trick to work either, at least not without little tears appearing in the edges of the paper as the points spread apart. Can you check your theory, and give more specific instructions?

-- Jeannine Mosely

Date: Sat, 12 Apr 1997 04:38:33 -0300 (ADT)
From: Rjlang@aol.com
Subject: Re: [propp@math.mit.edu: Margulis napkin problem]

To recap: Jeannine posted a query about whether it's possible
to fold a shape
with a perimeter larger than the original square; Mark Casida
suggested
squashing a Sea Urchin; and I observed that:

..you fold an order-N Sea Urchin (from Origami Sea Life).
It has N^2 points, each of length (1/(2(N-1))). ****If you make
the points
arbitrarily thin**** [emphasis added] (using lots and lots of
sink folds!),
when you flatten it, you'll get a total perimeter of N^2/(N-1),
which is
unbounded as N is large.

and

You don't have to go to this extreme, however. ****If you thin the
points**** [emphasis added] of a Bird Base, you can splay the points out
into a shape with a perimeter greater than [that of] a square.

Jeannine takes me to task:

>>>>

Not so fast, Robert! When you flatten the sea Urchin, portions of each point overlap neighboring points, reducing the total perimeter. And I can't get the bird base trick to work either, at least not without little tears appearing in the edges of the paper as the points spread apart. Can you check your theory, and give more specific instructions?

<<<<

I added the asterisks to my original comments to emphasize an important point; if you're really going to try this, you definitely have to thin the points, or as Jeannine points out, you'll lose perimeter due to the regions where the points overlap. The thinner you make the flaps, the less you lose. And in fact, as you'll see below, you have to thin them a _lot_ just to reach break-even.

To quantify this and to provide a specific example in the case of the Bird Base, take a unit square (I get these from OUSA Supplies) and fold a Bird Base in the all-flaps-down position (kite-shaped). Denote the height of the top triangle by z (z is (Sqrt(2)-1)/2, but that's not important to the argument). Now narrow all four long flaps (and the top flap) by sinking the _sides_ in and out on parallel creases, dividing each side into nths. After sinking, spread-sink one flap on each side, so you end up with a real skinny thing with one flap pointing upward and two flaps on the left and right pointing down. Reverse-fold two of the downward-pointing flaps out to each side, and spread the two remaining downward-pointing flaps slightly so there is a gap between them.

Now, your shape lies completely flat and has four long flaps and one shorter one. Because of overlapping layers, each of the long flaps, which ideally would have a perimeter of slightly more than (1), has lost (2z/n) in length. The top flap has a perimeter slightly over (2z). So the total perimeter of the shape is 4(1-2z/n)+2z = 4 + 2z(1-4/n) (actually a teensy bit more because of some angled edges, which I'm neglecting for now).

So if you compare this to the perimeter of the original square, you see that for n=4, you've just about broken even; but if you divide into 5ths or more, you'll come out ahead. And if you make the points "arbitrarily thin", which only occurs in pure mathematics and Origami Insects And Their Kin, the perimeter of the Bird Base shape approaches the value 4+2z, or about 4.414. Similar arguments (and many more sinks) apply to the Sea Urchin.

Robert J. Lang
rjlang@aol.com

Whether or not the problem is solvable or not, it is true that the idea of the problem itself confounds the napkin as a structural support system, by way of challenging it from a purely material position. The napkin itself functions as an object providing storage. The problem seeks to activate the material in such a way that it can question itself; supposing that there is more, but only by way of the collapse of the subject itself.

A Bygone Art

The work of contemporary artist Joan Sallas is confusing. Sallas produces works in the form of folding napkins. *The art of folding napkins*, is a particular art that has a rich history and its height is upheld to exist in the late Middle-Ages until the 17th century, or firmly within the period of European Baroque. Folded napkins were a part of meals for cultural elites of that time. Dinners were also understood to be significant social events, where rulers of lands would exhibit their extravagance by decorating their dining tables with as much embellishment as the Baroque is known for. In this case, folding very much means making representational sculpture out of napkins. Sallas is an artist working today by maintaining and recreating the practices of Baroque table setting. This consists of recreating table displays of elaborate folded cloth (napkins, tablecloths, etc.) in actual sites of historic significance to the pertaining time period.[9]

A Human Serviette

> *A Forgotten World of Folds*
>
> *The history of the art of folding can be traced back to ancient times. Many cultures have developed distinct folding traditions, which have crossed paths over the centuries. In Europe, the primary materials for folding practices have customarily been paper, parchment, and fabric. The practice of producing artistically folded tablecloths and napkins came into being in early sixteenth-century Europe. The first drawings depicting this fashion, dated around 1500, originated Italy, and although an exact location is not given, these probably emerged from Florence. While commonly believed to have first appeared in Asia (origami, which translates from Japanese as "to fold paper," rose in popularity in the seventeenth century), the European art of napkin folding, as Joan Sallas has explained, in fact evolved in close dialogue with the elaborately pleated clothing of the Renaissance and the culinary extravagances to which the garments were worn.*
>
> *Napkins soon became a status symbol: quickly institutionalized, an intricate code of etiquette was associated with them. The art of folding was practiced at every European court, which spawned many different forms of folding, as the ongoing competition of who had the most beautifully decorated table was always at hand. Fabulous shapes evolved, such heraldic signs, flowers, and copulating birds.*
>
> *Since much eating in the sixteenth and seventeenth centuries still included using one's hands, a large quantity of crisp, lily-white napkins at the table were impressive and indicated the good manners and refinement of the banquet's host.*
>
> *The napkins, frequently perfumed with rose water, were not only used to protect clothing and to wipe one's mouth: the eye-catching folded fabric was often designed to accommodate other decorative and utilitarian elements of the table, like place cards, menus, and toothpicks. Or to present eggs, sweets, or bread rolls in an elegant and playful manner. Sometimes beautiful*

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[9] Waddeson, The Rothschild Collection, *Folded Beauty: Masterpieces in Linen by Joan Sallas*, Exhibition leaflet, May 22 to October 27, 2013. From the leaflet:
“Waddesdon’s Dining Room was at the heart of the entertainment provided for Baron Ferdinand’s guests at his famous house parties, when the lavish appearance of the table complemented the exquisite meals that were served. An evocative photograph from 1897 shows the table dressed for dinner, laden with pink Malmaison carnations – a specialty of Waddesdon’s glasshouses – which echoed the pastel colours of Boucher’s tapestries on the walls.
Table decoration that created a visual counterpoint to the food has a long tradition that evolved according to changing fashions. The use of figures made of table linen, sugar paste or porcelain (like those displayed in the Starhemberg Room on the first floor) persisted from the Renaissance until the beginning of the 19th century, when they were replaced by extravagant displays of flowers and fruit. Since 1994 we have recreated the magnificent splendour of the Dining Room using one of the 18th- century Sèvres and Meissen porcelain services in our collection with different historical table decorations each year. The spectacular display of sculptural linen napkins by Joan Sallas is part of that tradition”

songbirds were hidden in the napkins to charm the guests as they, twittering and fluttering their little wings, made their delightful escape. At grand banquets such as coronation celebrations, the importance was not so much on taste and appetite as on ingenuity and display: the meal was not intended to feed so much as delight the senses and impress the guest with the hosts's wealth and status. Occasionally, the napkins were integrated into magnificent table decorations presenting folkloric tableaux full of castles, pyramids, and fountains spurting wine and rose water--all out of folded linens. In the gastronomical form of the total work of art, known in German as Schauessen--a theatrical production for the dinner table, or literally, "show meal"--napkins were key ingredients together with other forms of elaborate decorations and sculptural elements, the most treasured of which were the delicate sugar sculptures, sometimes clad in creased cloth.

The very first book about the use of napkins, Banchetti: Compositioni di vivande et apparecchio generale, by a certain Cristoforo di messisbugo, steward of Castle Estense in Ferrara, appeared in 1549. Messisbugo orchestrated many banquets, and in his book gives minute descriptions of the staging of these extravagant feasts, including everything from food and drink to accompanying music and dance, the setting of the tables with ornamental figures of sugar, numerous tablecloths and, of course, elaborately folded napkins. He recounts the intricately rendered arches, animals, and mythological figures made of the finest of linens.

Within a historical context, Messisbugo's book precedes the classic 1797 Hiden Senbazuru Orikata (The Secret to Folding One Thousand Paper Cranes, 1797), the oldest known origami publication, by nearly 250 years. However, were it not for the German thoroughness and, above all, the methodical mind of a certain Matthias Jäger from Bavaria, the Leon Battista Alberti of the art of folding, we would have had little knowledge of this noble art. Under the Italianated name Mattia Giegher, he taught at the University of Padua and wrote Li tre trattati (The Three Treatises), published in 1639. His illustrated publication was the first place in which basic folding techniques were recorded in writing--even the lexicon, with terms like "mountain fold" and "valley fold," which continue to prevail worldwide, was established in this seventeenth-century book. Giegher's discourse on folding methods was followed by several other books on the subject, including among others, Andreas Klett's Neues Trenchier- und Plicatur-Büchlein (New Carving and Plicature Booklet, 1677). All subsequent publications were directly or indirectly influenced by Giegher's pioneering work, without the fundamental techniques of folding during the Renaissance. Soon, literature on napkins increased, and numerous how-to books gained popularity across Europe. The literature allowed rivaling butters of grand estates, Who naturally wanted to stay au courant, not to have to travel to Rome or Florence to brush up on their skills, rather they could teach themselves new techniques and the latest forms. In this way, the fashions of the courts were made available to the upper echelon of society and those wanting to enrich their lives through the arts of the table.

Folded napkins shared their transient nature with more or less edible table decorations, sublime waterworks, and precious fireworks. The fleeting nature of these objects must have been an appealing quality in itself. Some of the folded art pieces did not even survive the hors d'oeuvres: a large mountain, a symbol of power, was folded out of a giant tablecloth and then placed on the table. The guests before it was flattened and dinner was served, the pleated opus reduced to its base materiality.

These fantastic showpieces for the table seem to have reached their peak in the late seventeenth century, gradually replaced by decorations made of of porcelain, most often associated with the eighteenth century. However, the artistically folded napkin has remained a beloved craft across the centuries, and is presently experiencing a revival due to Joan Sallas's tireless research and passion for the fold. The world of folds is infinite. Sallas loves them all: those of the past and those of the present, and particularly those yet to come.[10]

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[10] Charlotte Birnbaum, *The Beauty of the Fold: A Conversation with Joan Sallas*, volume II from *On The Table* series, Sternberg Press, 2012, p. 23

What is then confusing about the work is within this gesture of replication? Sallas reproduces forms that should be dead, and remain in the books and publications they came from. However, it is impossible to ignore the fact that the pieces made today are not and can never be the same pieces they are referencing. They are copies. Copies however made possible because in order to produce the works, the additional task of becoming a custodian of the texts and publications that preserve the knowledge and techniques of this craft is required.

> *CHARLOTTE BIRNBAUM:*
> *Do you find it difficult to practice a bygone art? What has your biggest challenge as a folding artist been?*
>
> *JOAN SALLAS:*
> *My biggest challenge is to understand my profession. To get out of bed every day and believe that what I'm doing has purpose—both for myself and for others. We live in a giant commedia mundi, and we know that everything we do has no intelligible purpose. Nevertheless, we make a huge effort to trick ourselves and believe that what we do is logical and useful, because it satisfies our need for intimate gratification or because it puts money in our pockets or because it rings applause in our ears. No, it is not logical or reasonable, but we continue to do it nonetheless. And this continuation is actually the biggest challenge. It would be much easier to answer this question with any artistic or technical provocation, or with a project to qualify it—like, for example, to found a folding museum (actually, I intend to create a folding museum somewhere in Europe). Everything that we do is irrational and surreal. Humans are the only animals that fold or that wear paper hats. That alone should show us that we're on the wrong track. […]*[11]

[11] Ibid, p. 16-17

Is the Napkin conjecture Open?[12]

The entirety of 'The Fold: Leibniz and the Baroque' by Gilles Deleuze. Translated 1993. [13]

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[12] This section title uses the word "open" intentionally, to reference another dichotomy between what could be considered open/closed, outward/inward, and again referencing a reversal, or a reflexivity—important to the idea of reflection itself.

[13] Gilles Deleuze, *The Fold: Leibniz and the Baroque,* 1993, The Regents of the University of Minnesota. First published in France as *Le Pli: Leibnitz et le Baroque*, Les Editions de Minuit, Paris, 1988. In Charlotte Birnbaum, *The Beauty of the Fold: A Conversation with Joan Sallas*, volume II from *On The Table* series, Sternberg Press, 2012, p. 16, Joan Sallas can be quoted saying, "The high art of folding napkins occurred without any significant evolution. It attained the highest artistic level in the early baroque era—a time when folds in general were very popular, a fact so elegantly explained by Deleuze in his *The Fold: Leibniz and the Baroque*—and, it has, over the centuries, become ever more plain, until today, the era of the paper napkin. Today, the folding of napkins is generally not considered art; it is a cultural fossil. Nevertheless, an intricately folded napkin shows a certain reverence toward a guest."

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In the 1930s, faculty in the Home Economics department and School of Drama began collecting costumes and textiles, and in 1958, the Costume and Textile Study Center, the first study center of its kind, was established. Elizabeth Bayley Willis, with help from Virginia and Prentice Bloedel, provided the first major donation – a gift of more than 1,800 textiles and costumes from India— to the Center.

In 1982, the Costume and Textile Study Center and the School of Drama's historic costume collection were formally transferred to the Henry. Now numbering more than over 18,000 objects – ranging in date from 1000 BCE to the present from countries around the world – these works are an important regional resource for the study of fashion, clothing, and design.

Fashionable dress, in which the fabrics, materials, design, silhouette, construction, and detailing change rapidly over time, provides clues to our past and information about social identity and status. The collection includes items from designers, manufacturers, and stores associated with dress from the late 18th century to present.

The collection has large holdings of handwoven, dyed, printed, and embroidered costume from India, Eastern Europe, Guatemala, Central Asia, and the Middle East. The preservation of traditional dress conventions is important to understand the changing role of dress, as in the past, each village had a unique identifying style.

The Blanche Payne Collection of Eastern European Folk Costume was collected in the 1930s. It represents traditional clothing from the former Yugoslavia, Czechoslovakia, Hungary, and Greece. Margaret Hord donated her collection of Eastern European costumes in 2003, complimenting and strengthening the collection.

In addition to forming the base for the clothing we wear, textiles are also produced for use in homes, ceremonies, and religious purposes. Our holdings consist of household textiles used for wall, floor, and bed coverings, as well as laces and fabrics ranging in date from the 16th to 20th centuries.

Harriet Tidball is one of the people responsible for the resurgence of hand weave in the United States in the 1950s and 1960s. Her collection offers an archive of hand weaving examples.

James D. Burns, a local rug collector, and his wife Stephanie have donated a collection of rugs and textiles from the Middle East and Central Asia, ranging in date from the 16th to 19th centuries.[14]

The passages above come from the Henry Art Gallery's website for the Collections at the Henry. Within the Henry's Collection is the category of Custome and Textiles which makes up only a portion of the entire collection; including works of Contemporary Art and Photography & Prints as other categories. Searching the keyword 'napkin' into the online database on the website yields 120 results, meaning there are precisely 120 napkin belonging to the collection of Costume and Textiles of the Henry.

In order to make the connection between the structural support system of the archive (the Collection) and the structural support system of the napkin elaborated on above, napkins were selected from this list in order to explore what measures were being taken concerning their conservation. The first thought one might have about napkins in an archive is what the state of those napkins is, cleanliness-wise. It is true that all stains and deposits of food, oils, residues, etc. are kept in tact on the napkin in whatever state they originally were. This is an important detail in understanding the napkins themselves

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[14] https://henryart.org/collections/costume-textiles

as structural, able to contain content that in this case contributes to a institutional relationship with history and knowledge, and knowing that the napkins as containers themselves, are contained within the archive.

For this reason the decision was made to gain access to the storage materials belonging to two of the napkins in the collection: the oldest napkin the collection, from Italy, dating to the 15th century, locating it within a time of aforementioned cultural status of Europe. Another from 1950 and the United States, specifically from the Harriet Tidball collection demonstrating hand weave, and also representing the youngest piece in the collection. These two napkins paired, establishing a formal equivalency between the former napkin and its context, and the latter with a more familiar context of our present cultural state. The storage materials involved in conserving these napkins are rolls; the napkins are rolled on the outside of tubes, between layers of Tyvek and unbuffered acid-free tissue. The rolls are then secured with unbleached cotton tying tape, and stored mid-air on archival roll-storage racks. With the napkins removed, the two empty napkin husks themselves resemble fabric napkins in a restaurant rolled around silverware and clasped with a ring around the center on a set table; they too are displayed without any of the normal display equipment normally used to show pieces from the collection. Without glass vitrines, controlled room lighting, and temperature adjusting, the rolls are laid on a table, openly and exposed, under natural light pouring in through the skylights.

Two more pieces accompany this one. On another table across from the napkins is populated with prints on shipping labels made with a desktop thermal printer. The prints themselves are rendered using a laser on direct-thermal paper. This means no ink is involved in the process of generating the print. More importantly, each print includes a vinculum bisecting the top and bottom of the 4” x 6” surface. The vinculum is a horizontal line used in mathematic notation, for the purposes of these prints, divide each print into two halves, following a vernacular of a bisection, or bifold. They remain in the half-circlular ship from also being stored as a roll. Following the logic of structural support systems is also presented in this work. The vinculum and text, or images on the prints are created by entering the proprietary document language, ZPL, only understood by the Zebra-brand thermal printer. In order to make the prints, ZPL code was written, and sent directly to the printer from a command-line interface.

Both tables used for presenting these works are tables borrowed from the Henry’s own supply of staging tables used for installation periods of exhibitions. Both of these tables were also wrapped in kraft paper.

Finally, the third piece included in the exhibition follows the idea of fold but in a different way. Two folding card tables stay folded and leaned against the wall next to an emergency exit from the gallery. The surfaces of the tables face outward —into the gallery. Wrapped around the upward sides of the tables’ frames are two black disposable self-adhesive paper napkin rings. The black rings blend almost seamlessly into the matte black paint coating the metal frames of the card tables. Only the interruption of the failing adhesive keeping the rings wrapped disrupts the two surfaces’ blend with one another. The logic of this representation of fold follows the conclusive definition of folding associated with poker, a card game. In the game, “folding” occurs when one gives up their hand of cards, reveals them to the competing players, and subsequently withdraws one’s place in the game. Folding in cards can be equivocated to ‘giving-up’.

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