Has the conjecture based on “fractal paper” been resolved?
Construction of Common Unfolding of a Regular Tetrahedron and a Cube

Toshihiro Shirakawa*  Takashi Horiyama†  Ryuhei Uehara‡

Any new results in a net for 3 different boxes?
Common Developments of Several Different Orthogonal Boxes

Zachary Abel*, Erik Demaine†, Martin Demaine‡, Hiroaki Matsui§, Günter Rote¶, Ryuhei Uehara‖

Common unfolding of $4 \times 4 \times 8$ box and $\sqrt{10} \times 2\sqrt{10} \times 2\sqrt{10}$ box

[Abel, Demaine, Demaine, Matsui, Rote, Uehara 2011]
Common Developments of Several Different Orthogonal Boxes

Common unfolding of $4 \times 4 \times 8$ box and $\sqrt{10} \times 2\sqrt{10} \times 2\sqrt{10}$ box

Courtesy of Zachary Abel, Erik Demaine, Martin Demaine, Hiroaki Matsui, Günter Rote, and Ryuhei Uehara. Used with permission.

[Abel, Demaine, Demaine, Matsui, Rote, Uehara 2011]
(a) 1x1x5

(b) 1x2x3

(c) 0x1x11

Courtesy of Zachary Abel, Erik Demaine, Martin Demaine, Hiroaki Matsui, Günter Rote, and Ryuhei Uehara. Used with permission.
Input : None;
Output: Polygons that consist of 22 squares and
fold to boxes of size $1 \times 1 \times 5$ and
$1 \times 2 \times 3$;
1 let $L_1$ be a set of one unit square;
2 for $i = 2, 3, 4, \ldots, 22$ do
3     $L_i := \emptyset$;
4     for each common partial development $P$ in
5             $L_{i-1}$ do
6             for every polygon $P^+$ of size $i$ obtained by
7                 attaching a unit square to $P$ do
8                 check if $P^+$ is a common partial
9                 development, and add it into $L_i$ if it is a
10                new one;
11           end
12       end
13 end
14 output $L_{22}$;

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[Abel, Demaine, Demaine, Matsui, Rote, Uehara 2011]
Courtesy of Zachary Abel, Erik Demaine, Martin Demaine, Hiroaki Matsui, Günter Rote, and Ryuhei Uehara. Used with permission.
Common Developments of Three Different Orthogonal Boxes

Toshihiro Shirakawa  Ryuhei Uehara*

Abstract

We investigate common developments that can fold into plural incongruent orthogonal boxes. It was shown that there are infinitely many orthogonal polygons that fold into two incongruent orthogonal boxes in 2008. In 2011, it was shown that there exists an orthogonal polygon that folds into three boxes of size $1 \times 1 \times 5$, $1 \times 2 \times 3$, and $0 \times 1 \times 11$. It remained open whether there exists an orthogonal polygon that folds into three boxes of positive volume. We give an affirmative answer to this open problem: there exists an orthogonal polygon that folds into three boxes of size $7 \times 8 \times 56$, $7 \times 14 \times 38$, and $2 \times 13 \times 58$. The construction idea can be generalized, and hence there exists an infinite number of orthogonal polygons that fold into three incongruent orthogonal boxes.

1 Introduction

Since Lubiw and O’Rourke posed the problem in 1996 three incongruent orthogonal boxes of size $7 \times 8 \times 56$, $7 \times 14 \times 38$, and $2 \times 13 \times 58$ (Figure 2).

The construction idea can be generalized. Therefore, we conclude that there exist infinitely many orthogonal polygons that can fold into three incongruent orthogonal boxes.

Figure 1: Cubigami.
Common unfolding of $a \times b \times 8a$ box and $a \times 2a \times (2a + 3b)$ box

[Shirakawa & Uehara 2012]
Common unfolding of $a \times b \times 8a$ box and $a \times 2a \times (2a + 3b)$ box

[Shirakawa & Uehara 2012]

Courtesy of Toshihiro Shirakawa and Ryuhei Uehara. Used with permission.
Common unfolding of $a \times b \times 8a$ box and $a \times 2a \times (2a + 3b)$ box

[Shirakawa & Uehara 2012]
[Shirakawa & Uehara 2012]

Courtesy of Toshihiro Shirakawa and Ryuhei Uehara. Used with permission.
Courtesy of Toshihiro Shirakawa and Ryuhei Uehara. Used with permission.
\(4k + 7 \times 2(k + 4) \times 8(4k + 7)\)
\((4k + 7) \times 2(4k + 7) \times 2(7k + 19)\)
\(2(k + 1) \times (4k + 3) \times 2(16k + 29)\)

Common unfolding of three boxes

Courtesy of Toshihiro Shirakawa and Ryuhei Uehara. Used with permission.
I’m kind of unsettled by the non-area-preserving unfolding. If it were a true limit then we’d be able to get arbitrarily close to the non-preserved area by unfolding into sufficiently many pieces. But this isn't the case: either we get the non-preserved area by unfolding into infinitely many pieces, or we get the original area, by unfolding into finitely many pieces.
Photographs of Strandbeests removed due to copyright restrictions.
Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/14648143

“Ordis 2007”
Theo Jansen’s *Strandbeests*

Photographs of Strandbeests removed due to copyright restrictions.

\begin{align*}
a &= 38 \\
b &= 41.5 \\
c &= 39.3 \\
d &= 40.1 \\
e &= 55.8 \\
f &= 39.4 \\
g &= 36.7 \\
h &= 65.7 \\
i &= 49 \\
j &= 50 \\
k &= 61.9 \\
l &= 7.8 \\
m &= 15
\end{align*}

“Eleven holy numbers”

[Theo Jansen]
Image by MIT OpenCourseWare.
Theo Jansen’s *Strandbeests*

http://youtu.be/NM4q-f68TlY

“strandbeests ... mechanism”

petabyte99
2 legs lie in plane
33% higher step
4% faster stride

\( \gamma \)-reflectional symmetry
50% less stride height variation
50% less stride x velocity variation

Jansen mechanism

Ghassaei mechanism [2011]

Courtesy of Amanda Ghassaei. Used with permission.
Jansen mechanism

Ghassaei mechanism [2011]

center of mass

85% less center of mass movement

Courtesy of Amanda Ghassaei. Used with permission.
Theo Jansen’s *Strandbeests*

Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/24278413  “Animaris Gubernare — Tumble”
Theo Jansen’s *Strandbeests*

Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/51811740

“Animaris Adulari”
Theo Jansen’s *Strandbeests*

Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/52745220

“about the wings”
Theo Jansen’s *Strandbeests*

Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/44057387

“Adulari lifting itself ...”
Theo Jansen’s *Strandbeests*

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Theo Jansen’s *Strandbeests*

Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/14646877  “Untitled”
Photographs of Strandbeests removed due to copyright restrictions.

http://vimeo.com/11150979

“Rhinoceros”
Photographs of Theo Jansen assembly kits removed due to copyright restrictions.
Refer to: http://www.strandbeest.com/shop/index_usa.php.
To view video: http://www.youtube.com/watch?v=tHXy1nmVXg4 &
http://www.youtube.com/watch?v=i8KvXy-vluU.
Kinetic Creatures

http://www.kineticcreatures.com

http://vimeo.com/52366409
Land Crawler eXtreme Locomotion Demo Video

http://youtu.be/U5dpGAw4cOU

vagabondworks
Poster for "Ocean Beasts" exhibit at The Simons Center (July-August 2012) removed due to copyright restrictions.
Machine with 23 Scraps of Paper

Margot's Other Cat

Arthur Ganson

Machine with Roller Chain

Machine with Oil