Weft Computation of Endek Weaving

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Weft Computation of *Endek* Weaving

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Abstract

Endek is a textile produces in Bali with a single ikat technique, specifically weft ikat. Weft ikat means that the pattern is created or drawn on the weft threads before ikat or tying process. The weft threads are transferred into a frame; a frame consists of tens to hundreds of bundles or called traditionally as *bulih*. Drawing a pattern on a frame requires special expertise as the pattern maker has to translate a two-dimensional pattern into a shape that is distorted on the wide side. Indirectly, this special requirement confines the pattern maker as they have to visualize a distortion shape to be able to draw in the frame. To provide easiness in design exploration, providing various templates and multiplier to automatically distort the template are substantial. Therefore, understanding the manual process on site is important before simulating the formula of weft computation including are templates and multiplier. With this computation, the pattern makers or anyone who has an enthusiast in designing *Endek* patterns may involve in the design process.

Keywords: *bulih,* computation, *Endek*, pattern, weft

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1 Introduction

Traditional textile is created through a process of weaving, where the warp and weft threads intersect in a loom. *Endek* as one of the Balinese traditional textiles is produced with the weft ikat technique. According to Schaublin et al "ikat (Indonesian "bundle," *mengikat* "to tie") is a complicated and time-consuming resist dye technique in which undyed yarns are mounted on a frame in bundles" [1]. The pattern that appears in *Endek* is created on the weft threads. To create a pattern on the weft threads, the pattern maker needs to have proficiency in visualizing two-dimensional shapes into distorted shapes on the wide side. In addition to that, the pattern maker also needs to decide the number of round threads or bundles to set in the frame (called *penamplikan* traditionally). The number of bundles (called *bulih* traditionally) is varied from one design to another, mostly between fifty to hundreds of *bulih* in one frame.

The expertise of creating the pattern in the weft threads passes from generation to generation verbally and is not well documented. To preserve this cultural creation, transforming it into digital formats is essential. Defined according to the Guidelines for the Preservation of Digital Heritage as "texts, databases, still and moving images, audio, graphics, software, and web pages, among a wide and growing range of formats" [2]. There are challenges in keeping this digital heritage usable and available, especially for the community that owns the tradition. Today, globalization poses significant challenges to the survival of many traditions, one of which is traditional forms of craftsmanship design. Young people in communities may find the required, sometimes-lengthy apprenticeships too demanding, though they are necessary to learn the many traditional forms of the craft. This knowledge may disappear if family or community members are not interested in learning them.

The process of transforming an oral tradition into a digital form involves careful decoding to avoid misinterpretation. According to Pebryani, "the resulting cultural creation produced is based on the cultural knowledge owned by the local people in a specific area" [3]. This cultural knowledge entails indigenous algorithms consisting of the grammar and computation used by the artisans to create their textile. Hence, investigating the pattern design and computation of the weft threads in the process of

designing *Endek* will provide complete documentation on *Endek* weft ikat design process.

2 Research Methodology

The research methodology used in this study is to explore and explain the cultural knowledge and indigenous algorithm in the process of patterning *Endek* textiles. The methodology includes descriptive and simulation, meaning the study is divided into several stages. According to Sommer, "the steps involved in conducting a simulation include formulating the model, simulating the event, and analyzing the results" [4]. Therefore, as shown in Figure 1, this study is divided into three stages: (1) investigating *Endek* textile patterns on-site, (2) simulating the weft computation, (3) assessing the weft computation into the actual threads.

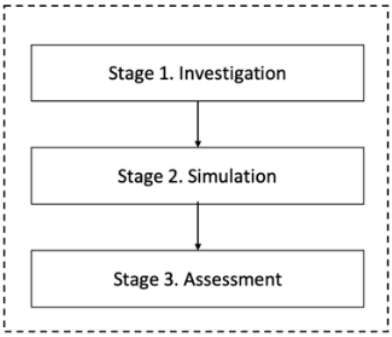

Figure 1. Stages in understanding the weft threads computation

The data was collected from interviews and participant observations with five pattern makers and weavers from various weaving centers. The participant observation allowed the researcher to see and infer information that people may not have mentioned during an interview. The researcher made appointments with participants, including the pattern makers and weavers. Both the interviews and observations took place while participants worked and lasted 60 minutes each. The researcher observed the activities of the participants, including pattern making, the steps involved in creating the patterns, and other phases of the process. The data achieved from the on-site investigation is

necessary to be used as a guideline to conduct the second stage to avoid misinterpretation in decoding the patterns design of *Endek* textile. As well as the information from the first and second stage are significant to be used in the assessment stage.

3 Results and Discussion

The data from the site was analyzed and discussed in three sub-topics: investigation, simulation, dan assessment. Investigation discusses how the process of creating *Endek* on-site including the process of counting threads and patterns. Simulation examines formula of bundles on frame related with the pattern on *Endek* textile. Assessment tests the formulas into the actual *Endek* design process.

Investigation. Creating *Endek* textiles follows several steps. Warp and weft threads are treated with a different procedure. Procedure for warp threads: coloring or dyeing the warp threads, putting the warp threads into a non-machine weaving loom. According to Pebryani, "the treatment and procedure of the warp and weft yarns in the *Endek* weaving consist of approximately 14 stages" [5]. Procedure for weft threads as shown in Figure 2, consists of splitting weft threads, transferring weft threads into a frame, drawing patterns on the weft threads, tying the weft threads, dyeing weft threads, coloring the second and third different colors on the weft threads. After both threats are processed, then both are ready to weave with a non-machine weaving loom as shown in Figure 2.e.

(a) (b)

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(c) (d)

(e) (f)

Figure 2. (a) splitting weft threads; (b) transferring weft threads into a frame, (c) drawing pattern on a weft threads frame, (d) tying patterned weft threads frame, (e) coloring weft thread frame, (f) weaving on a non-machine weaving loom

The weft threads are stored on a frame prior to drawing the pattern on the threads. A frame consists of several *bulih*, and a *bulih* contains several round threads. One round thread consists of 28 to 30 strands of yarn. The number of *bulih* is vary depending on the desired pattern to be created, approximately around fifty to hundreds of *bulih* in one frame. An experienced pattern maker has already computed the number of *bulih* during the process of transferring the weft, based on the pattern which the pattern maker desired. Hence, the pattern design needs to be decided before transferring weft threads to the frame. Figure 3. shows the size of the frame, 108 x 100 centimeters. In the width size of 108 cm, 7 cm and 1 cm on both left and right of the frame are reduced, leaving 92 cm for the drawing area. The distance between *bulih* is 1 cm.

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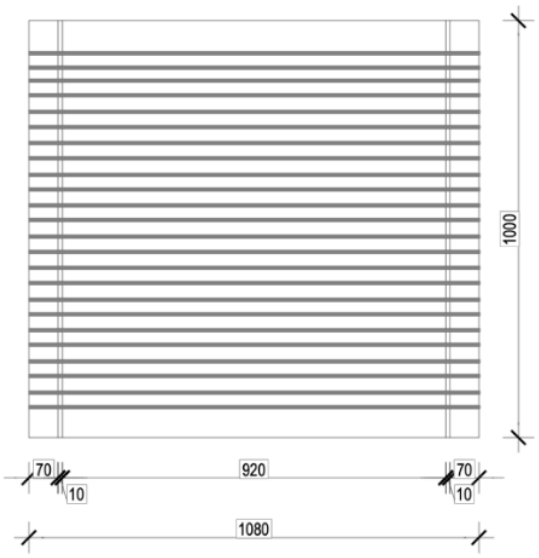

Figure 3. A frame of weft threads

As shown in Figure 3, the pattern maker draws in the area of 92 cm x 100 cm. After the frame is prepared, the pattern maker draws helper lines vertically every 2 cm or so. These lines will assist the pattern maker in dividing space or area on the weft threads. The drawing process uses a marker in navy or red color. The downside of this process is difficult to undo or erase lines that have been created. Hence, not many junior pattern makers are able to explore new designs in the weft threads. They mostly follow images or patterns they have already drawn before.

Designing a pattern for *Endek* in frame is different compared to designing a pattern in a template. When designing a pattern in frame, the pattern maker has to visualize a two-dimensional shape into a distortion shape on the wide side. It limits the pattern maker during design exploration. To provide easiness for beginner pattern makers or experienced pattern makers, transferring this knowledge into a digital format is essential.

Simulation. Paulus Gerdes using the study of mathematics in culture found that the craft art created by the indigenous people involves calculations (or hidden logic) that

indigenous people pass on from generation to generation [6]. Thus, to understand indigenous algorithms on weft computation is through studying and involving in local activity of designing Endek textile. Knowledge gathered across interviews and participant observations from several pattern makers and weavers are simulated to acquire a formula for the template as well as *bulih* computation. One frame consists of tens to hundreds *bulih*, in one *bulih* consist of several bundles (where one bundle consists of two-time thread pulling), bundles traditionally called "as". One-time thread pulling consists of 28 strands of yarns, where 28 strands of yarns create a 1 cm length of textiles. Therefore, 28 becomes a divider in order to seek a multiplier as shown in Table 1. The formula for the multiplier is:

$$1.\, Multiplier = \frac{28}{bundles\ x\ 2}$$

Table 1. Multiplier computation

bundles (As)	Multiplier
2	7
3	4.6
4	3.5
5	2.8

The template for designing the pattern has a fixed height with distinctive widths. As shown in Figure 4.a., a design created on a template with a size of 92 x 28 cm. Then in Figure 4.b, the pattern's design in Figure 4.a. is transformed into a weft threads frame. To identify the size of designated weft threads frame, the width size of a template times with the multiplier from the bundles that preferred. As shown in Figure 4.b, the width size is altered from 28 to 98, that comes from 28 times to 3.5 (multiplier from bundles four).

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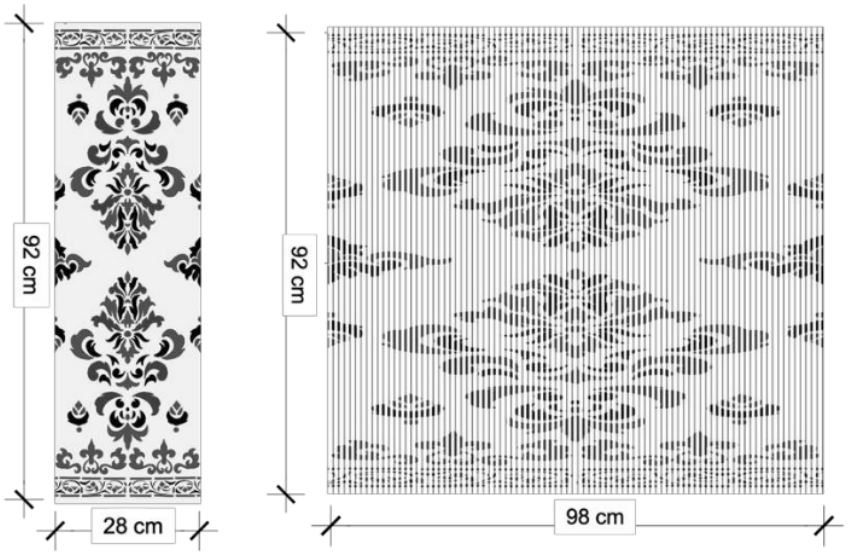

Figure 4. (a) left: *Endek's* pattern design in a template; (b) right: *Endek's* pattern design in a frame

$$2.\, Bulih = multiplier\ x\ the\ width\ of\ the\ template$$

Subsequently, knowing the number of *bulih* and the bundles can be used to compute the length of *Endek* textiles (as shown in Table 2) with the formula as follow:

$$3.\ \text{The textile length} = \frac{30}{28} x\ bulih\ \text{x (bundles x2)} x\ 2$$

Table 2. The width, *bulih,* and the result

The width of the template	*Bulih* for *As* 4	*Bulih* for *As* 3	*Bulih* for *As* 2	result
28 cm	98	128	126	1680 cm
26 cm	91	120	182	1560 cm
24 cm	84	110	168	1440 cm

22 cm	77	101	154	1320 cm
20 cm	70	92	140	1200 cm
18 cm	63	83	126	1080 cm
16 cm	56	74	112	960 cm
14 cm	49	64	98	840 cm
12 cm	42	55	84	720 cm
10 cm	35	46	70	600 cm
…	…	…	…	…

Assessment. Theorems need to be presented through illustration or graphs in order to see how the theorems or formulas have been proven [7]. The frame as shown in Figure 4.b. is printed with a scale of 1:1 and created holes on it as a mold to allow ink to permeate on the weft threads frame as shown in Figure 5.a. The signed ink on the weft threads frame then is tied as shown in Figure 5 b.

Figure 5. (a) left: the weft threads frame that have been patterned; (b) right: the weft threads frame that the patterns have been tied

After the weft threads have been tied according to the patterns, the next process is coloration basic dye followed by desired colors. Later, the threads are split into a

shuttle. This shuttle of weft threads passes the warp threads horizontally or from right to left and reverse, until an *Endek* textile is materialized as shown in Figure 6.

Figure 6. *Endek* textile pattern as the result from the design on the left side

4 Conclusion

The computation of weft threads provides easiness in designing the patterns for *Endek* textiles by providing various template dimensions. In addition to that, with the multiplier, the template can automatically stretch on the wide side to transform it into *bulih*. The *Endek* design pattern created through this computation has been assessed until it created a textile. The computation of weft threads contributes a benefit in transforming the manual process into a digital process in designing *Endek* patterns as well as encouraging the pattern maker more explorative.

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