

Developing New Patterns for Local Weaving Using a Mathematical Algorithm

Lawrence A. Eclarin^{1,*}, Ciriaco T. Ragual¹, Wilben Christie R. Pagtaconan²,
Lawrence John C. Tagata³, Leonila Y. Rico⁴

¹Associate Professor, Department of Mathematics, Mariano Marcos State University (MMSU), City of Batac 2906 Philippines

²Associate Professor, Department of Computing and Information Sciences, Mariano Marcos State University (MMSU), City of Batac 2906 Philippines

³Assistant Professor, Department of Electronics Engineering, Mariano Marcos State University (MMSU), City of Batac 2906 Philippines

⁴Handicraft Worker, College of Industrial Technology, Mariano Marcos State University (MMSU), Paoay Ilocos Norte 2902 Philippines

*Corresponding author. Email: laeclarin@mmsu.edu.ph

ABSTRACT

Abel Iloko is a loom woven cloth made by local weavers of the Ilocos region in the Philippines. Paoay is one of the few municipalities in the province of Ilocos Norte who still practice the weaving tradition. Commercialization, globalization and tourism development in the region have contributed to the demands in production which include variety in patterns and innovative designs. The research aimed to develop new patterns and designs for the local weaving industry in Paoay, Ilocos Norte in collaboration with the Nagbacalan Loomweavers Multi-Purpose Cooperative. New patterns were generated using a mathematical algorithm involving square matrices and a computer application developed for pattern generation. The nets formed by matrices were superposed to create pleasing designs and translated to weaving drafts. The study was able to generate more than 20 new patterns which can be used to weave pick-up designs.

Keywords: loom weaving, weaving draft, pattern generation

1. INTRODUCTION

The Abel Iloko is an integral part of the culture and arts of the Ilokanos. Abel Iloko is a collective term that refers to the weaving process (abel) and the woven product (inabel). Inabel are classified into various types which employ different techniques: banderado (from the term bandera or flag), consisting of colored stripes; binakol, with op-art swirls called kosikos; nagkudil or face-to-face, reversible designs; sinukitan or insukit, embroidered-like designs; and others. The materials used for weaving are mostly cotton but these can also be derived from other unlikely raw materials like bamboo (Bambusoideae), saluyot (*Corchorus olitorius*) and even seaweeds. The use of the inabel is very common in households among Ilokanos which include rags, table mats, runners, bed sheets and pillowcases. In more recent times, due to the ingenuity of the Ilokanos, the inabel has found its place in fashion where the fabrics are used for

designer gowns and suits, and in interior designs where inabel is used for cushions, upholstery and others. Moreover, the continued growth of tourism in The Ilocos Region has helped in the promotion of the inabel.

1.1. Mathematics and the Abel Iloko

The observable patterns seen in loom woven products has caught the interest of many mathematicians. The paper of Baylas et al. (2012) presented mathematical concepts exhibited by weaving patterns on the fabrics of the Northern Kankana-ey in the Mountain Province. In the Province of Ilocos Norte, a study on the characterization and investigation of symmetries present in the woven products was conducted by Ragual (2013) on the Abel Iloko.

Cabansag et al. (2014) used matrices to generate colored transitive patterns that may be used for weaving but the results cannot be woven due to technical aspects

of the loom. By applying the results of F. Fernandez (1998) to create pleasing designs for *azulejos*, which are tin-glazed tiles made in Spain and Portugal, new patterns were generated using a technique described in his paper. Pagala et al. (2015) were able to create new patterns for the Abel Iloko using canonical matrices of prime determinants as defined by Fernandez.

In 2018, De Las Penas, et al. (2018) analyzed a representative sample of Philippine indigenous textiles to capture the range of symmetries and color symmetries present. The study also aimed to determine the tendency of a particular symmetry to be more or less common than another which indicated relationships between symmetries and the weaving technique or the culture that produced them.

1.2. Statement of the Problem

With the advent of modern technology which result to developments in product designs and innovations, locally manufactured products face a more competitive market of global standards. Moreover, there is waning interest in the weaving tradition among the youth as evidenced by the few number of young weavers. The local handicraft has been defined as a “dying tradition” due to these reasons and other challenges facing the industry at present (Inabel, undated.).

This study was conducted to develop new patterns and designs for the local weaving industry which could help sustain the weaving tradition. In particular, patterns were generated for new designs, trainings were conducted to enhance weaving techniques and promote weaving to young people, and regular consultation meetings with local weavers were organized to identify problems and formulate solutions.

2. METHODOLOGY

2.1 Locale of the Study

In the province of Ilocos Norte, the municipalities of Paoay, Sarrat and Pinili are well known places for weaving inabel. In Paoay, the Nagbacalan Loomweavers Multi-Purpose Cooperative (NLMPC) is the leading advocate in the promotion of Abel Iloko. The cooperative was founded in 1992 which originally consisted of 13 female weavers which increased to around 30 active members.

In the study, the NLMPC loom weaving facility in Nagbacalan and the loom weaving center of Mariano Marcos State University (MMSU) at the College of Industrial Technology served as project sites for loom execution testing and final product weaving.

2.2. Research Design

The study was a collaborative research between MMSU and NLMPC and used a combined R&D and D&D research design. A mathematical algorithm was formulated to generate new patterns and a computer application was developed to translate these to weaving drafts. The drafts were used for loom execution and woven prototypes were evaluated for production. The research project coordinator, a handicraft worker of MMSU, performed product testing and prototyping while four expert weavers from the cooperative were involved in the final production of woven cloths.

2.3. Generating New Patterns and Designs

In order to create the new patterns, the following mathematical concepts were applied.

A 2×2 square matrix is an array of numbers, written in the form $\begin{bmatrix} a & c \\ b & d \end{bmatrix}$. The *determinant* of the square matrix is given by $ad - bc$. A square matrix of the form $\begin{bmatrix} p & q \\ 0 & r \end{bmatrix}$ where p, q, r are integers, $p > q \geq 0$ and $r > 0$ is said to be in *canonical form*.

The *net* generated by a matrix of canonical form is a subset of a square grid generated by the two linearly independent column vectors $\begin{bmatrix} p \\ 0 \end{bmatrix}$ and $\begin{bmatrix} q \\ r \end{bmatrix}$.

The algorithm for generating a pattern is presented in Figure 1.

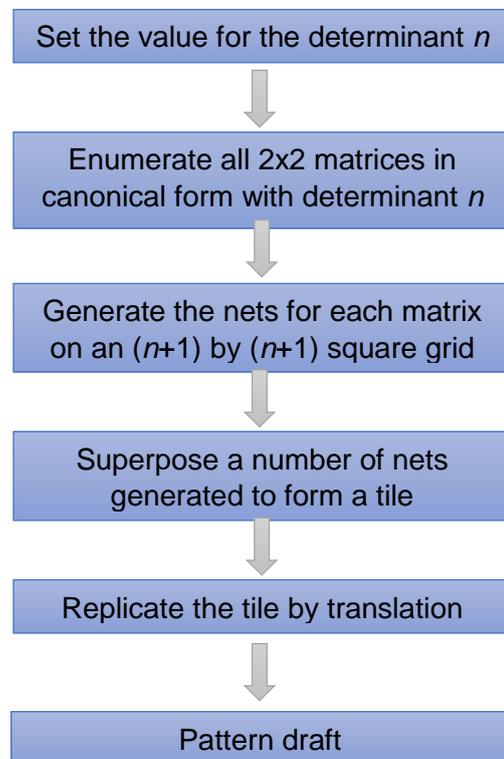


Figure 1. Algorithm for Generating a Pattern Draft

In the algorithm, n should be a positive integer greater than 2. The number of 2×2 matrices of determinant n is given by the sum of all positive integers that divide n . Patterns generated by superposing nets with their reflections have more symmetries than others.

For example, the tile and the pattern generated by superposing the nets formed by $\left\{ \begin{bmatrix} 7 & 6 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 7 & 1 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 7 & 5 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 7 & 2 \\ 0 & 1 \end{bmatrix} \right\}$ are given in Figure 2.

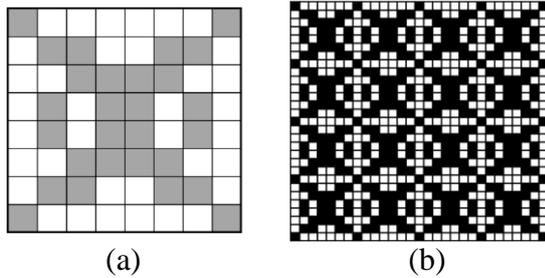


Figure 2. a) Tile and b) pattern generated by the nets corresponding to the matrices $\begin{bmatrix} 7 & 6 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 7 & 1 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 7 & 5 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 7 & 2 \\ 0 & 1 \end{bmatrix}$

Based on the algorithm, Aa computer application based on the mathematical algorithm was also developed which was used to create computer printouts of weaving drafts. Loom testing was executed using the drafts and the prototypes were evaluated prior to final production.

2.4. Training Programs

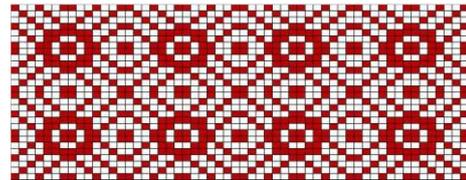
Two training workshops were organized under the study: for expert weavers and for beginners. A two-day training for expert weavers was conducted which aimed to present mathematically generated patterns and designs for the Abel Iloko, to assess existing patterns which served as basis for creating new patterns, and to form a pool of expert weavers that served as key informants and were involved in the final production. A training for the basic loom weaving workshop for beginners was also conducted. The five-day training aimed to inform novice weavers with basic weaving procedures and terminologies used in the weaving process. The training also served as venue for the initial assessment of new patterns generated and to familiarize the weavers with the weaving drafts. The basic training for beginners was conducted to recruit and entice young weavers. Basic steps in loom weaving and the tools used were demonstrated.

3. RESULTS AND DISCUSSION

In this study, twenty (20) new patterns were generated and nine were arbitrarily chosen for final production. One of the patterns selected and the resulting woven cloth are shown in Figure 3. Contemporary designs and color

matching were employed to come up with innovative products like bags, clothing and upholstery as shown in Figure 4.

In this study, twenty (20) new patterns were generated and nine were arbitrarily chosen for final production. One of the patterns selected and the resulting woven cloth are shown in Figure 3. Contemporary designs and color matching were employed to come up with innovative products like bags, clothing and upholstery as shown in Figure 4.



(a)



(b)

Figure 3. a) The “mystika” pattern and b) the woven cloth showing the “mystika” pattern.



Figure 4. Contemporary bags showcasing the new Abel patterns.

Similar to traditional means of naming indigenous patterns like “kosikos” for *binakol* which showcases swirling patterns, the new patterns generated were named based on noticeable shapes or associated characteristics.

For example, the *mystika* pattern was named after Mystica, a Filipino pop rock diva who is fond of using red lipstick. The diamond design was simply named after the diamond shapes formed.

In the course of the study, challenges faced by the weavers were raised which included the lack of low-cost raw materials available locally, unsteady order from customers, and bargain prices of woven products. These concerns can serve as basis for government to formulate community programs to sustain the local weaving industry and facilitate inclusive growth.

4. CONCLUSIONS AND RESEARCH DIRECTIONS

This study establishes the importance of research in product development and innovation. For the weavers, the project introduced innovative ways of generating new patterns and designs for the Abel Iloko and other means of enhancing hand-woven products. The trainings conducted enabled them to share and discuss techniques on weaving which could help facilitate better production.

Moreover, the results of the study provided new research directions that can be undertaken.

Software development. A computer application can be developed which could readily provide the threading and threadling drafts for a given pattern and product simulation. The number of harness needed will be easily determined and the product simulation can provide the weavers with a virtual image on the final woven product for initial assessment and evaluation.

Local yarn production and development. This will address the major problem of local weavers which is the source of locally available and affordable threads for weaving. Government agencies like PhilFIDA and DOST-PTRI have been providing free trainings to local weaving communities including dyeing. However, the skills learned cannot be readily applied due to unavailability of locally spun cotton threads.

Marketing and commercialization. Efficient marketing strategies and commercialization will help ensure steady order and income which will benefit weavers.

ACKNOWLEDGMENTS

This research was funded by the United States Agency for International Development (USAID) under

its Science and Technology for Research Innovation and Development (STRIDE) Program. The authors also gratefully acknowledge the use of the services and facilities of the Nagbacalan Loomweavers Multi-Purpose Cooperative in Paoay, Ilocos Norte.

REFERENCES

- [1] Baylas, N. A., Rapanut, T. A. and De las Penas, M. L. A. N. (2012) Weaving Symmetry of the Philippine Northern Kankana-ey. *Bridges 2012: Mathematics, Music, Art, Architecture, Culture*. Retrieved from <https://archium.ateneo.edu/cgi/viewcontent.cgi?article=1038&context=mathematics-faculty-pubs>
- [2] Cabansag, H. A. S., Ramos, E. B. and Eclarin, R. P. (2014). *Generating colored transitive patterns for the Abel Iloko* (Undergraduate Thesis). Mariano Marcos State University, Batac City, Philippines
- [3] De Las Peñas, M. L. A. N., Garciano, A., Verzosa, D. M., & Taganap, E. (2018). Crystallographic patterns in Philippine indigenous textiles. *Journal of Applied Crystallography*: 51, 456-469 <https://doi.org/10.1107/S1600576718002182>
- [4] Fernandez, F. (1998). A class of pleasing periodic designs. *The College Mathematics Journal*: 29(1) <https://doi.org/10.2307/2687631>
- [5] Inabel: Modern Design from a centuries-old tradition. (n.d.). Retrieved from <https://www.kickstarter.com/projects/1499963305/inabel-modern-design-from-a-centuries-old-traditio>
- [6] Pagala, J. C., Agarpao, A. M. and Eclarin, L. A. (2015) *Azujelo pattern in the Abel Iloko* (Undergraduate Thesis). Mariano Marcos State University, Batac City, Philippines
- [7] Ragual, C.T. (2013). Mathematical characterization of the patterns of the Abel Paoay [Abstract]. *33rd Annual PAASE Meeting and Symposium Book of Abstracts*, 223.
- [8] Royandoyan, R. H. (2012, May 21). Asean forum sets sights on regional weaving tradition and industries. *Philippine Daily Inquirer*. Retrieved from <https://lifestyle.inquirer.net/48943/asean-forum-sets-sights-on-regional-weaving-traditions-and-industries/>