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DigiBunai™ - Open Source CAD Software for Sustainable Handloom Industry in India

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***Abstract:** This paper aims to raise awareness about DigiBunai™, an open-source CAD technology developed by Digital India Corporation (DIC) under the auspices of the Ministry of Electronics and Information Technology, Government of India. This initiative has been taken by the Indian government to support handloom designers and weavers with the use of ICT solutions and make the handloom sector sustainable. One of the major aspects of this paper is to understand the various stages of design development for woven products concerning manual methods as well as functions available in CAD software. This paper explains how the newly developed technology can help to reduce the time and effort required to create intricate designs of handloom products. The information regarding the use of technology to create weave patterns, artworks, and simulated fabrics has been summarized here, with the option to view the entire layout of the product. The uniqueness of this technology is that it can be used to design traditional Indian saree, which is the most significant value-added product of Handloom Weavers of India.*

***Keywords:** CAD, Handloom, Weaver, Fabric, Textile*

I. INTRODUCTION

Handloom is the soul of the textile heritage of India. It connects the basic requirements of humans with the culture and traditions of India. Handloom products differ from one community to the next and are unique to the regions where they are produced. It is influenced by differences in raw materials, dyeing colors, patterns, motifs, and manufacturing techniques, among other things. The artists of Handloom have high skills in designing, and they perform laborious tasks of production by hand. The skills of artists are transferred from one generation to another within their community. So the crafts of the craftsmen are retained by the respective communities in specific regions of India. One factor is that the more time spent on design and production, the higher the market price of these products. Furthermore, because of the reliance on manual methods of design, human-generated errors are sometimes visible on fabrics, which detract from the product's appearance and lower its market price. Apart from the efforts and complexity involved in the production of handloom products, they have several advantages concerning flexibility to modify at any stage, Design durability, finer degummed silk yarn weaving, multicolor weaving (more colors than power loom weaving), etc. Nowadays, handloom weaving faces issues concerning its sustainability concerning power loom weaving. The power loom sector works on the mode of bulk production of fabric in less time and at a lower cost. This sector is capable of creating a balance between market demand and fabric production. It is also capable of catering to newly generated product needs according to frequent changes in market trends and consumer liking. Handloom weaving is associated with traditional artists who are unable to afford the costly technologies and produce the products through conventional manual methods of weaving. A question has been raised about the sustainability of the craftsmen's livelihoods because many artisans are the sole source of income for their families and are completely reliant on handlooms. So, two basic requirements arise from this situation: one is to preserve the textile heritage of India, and the other is to increase or provide livelihood opportunities to the Indian handloom artisans. From the above concern, the primary objective is to support the handloom sector by optimizing the production process with the availability of affordable technologies. It also aims to connect handloom artists with the world of virtual reality textiles.

II. LITERATURE REVIEW

CAD software is currently the backbone of the organized textile industry, where it is greatly utilized for designing and production. It is an integral part of the designing process since it helps the artisans to design and even exhibit the result on the computer screen to satisfy the customer before the weaving. From visualizing ideas to creating designs and fabrics that are more appealing to the customer, CAD offers the opportunity to the artisan to keep up with the rapidly changing fashion trends and customer demands. [1].

Textile designing software helps designers by improving their capability as well as enhancing their creativity. With the software packages available to them, the designers can experiment with several colors, fabric textures, patterns, and motifs to produce the perfect design. The availability of concept boards on which they can sketch the background, repeat the patterns, map the textures, and render product designs aids designers in reaching their full potential.

In textile production, different levels of applications refer to the stages of production. Textile designers are in charge of producing various forms of textile products, for which they either work from their original ideas or abstract designs.

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CAD can be used efficiently in conceptualizing designs to produce high-quality textile products that have a higher market value. Designing and its application in the manufacturing process have many challenges when each step is done manually. Using CAD software helps overcome most of these challenges by aiding in the conceptualization of the designs. It also helps in improving the designs by offering flexibility to modify them at an early stage. Its simple tools also help in developing complicated patterns and complex designs with ease, making the process simple, time-saving, and cost-efficient. [2]

CAD software also eliminates wastage by offering images in each step, which was earlier done manually by the designers using various colors and different designs in each sample batch that they had to produce to see how it looks. The software enables the designers to see how the product will look with different colors, motifs, and designs without having to produce them, saving time and money on sample production. Another benefit of CAD software, which makes it indispensable, is that the conceptualized and created designs can be stored, modified in the future, and easily shared with weavers across the world. [3]. Since design is the foundation of the handloom sector, it is very important to ensure that appropriate design support and marketing are provided. Currently, under the Integrated Handloom Development Scheme, they are getting very limited support and promotion. [4]. The method of production has been a huge concern in the Indian handloom industry. To ensure better efficiency of the production system, the latest technology needs to be applied and the processes need to be upgraded with the same. Proper training of the handloom artisans is also required to produce defect-free items. The knowledgeable and skilled artisans can produce products that can attract more designers and investors to Indian handlooms, not just at the country level but also at the global level. [4]

The problems currently being faced by the handloom sector in India include the shortage of raw materials, lack of availability of business capital and credit/loans, uncomfortable working conditions, unfitting design quality, scarcity of modern and unique designs, institutional inefficiencies, lack of research training and skill-development efforts, the unorganized nature of the industry, a paucity of sales and marketing agencies, more earning in other vocations making handloom seem like a less lucrative industry, the unavailability and lack of understanding of schemes, and the lack of interest in upcoming generations to carry forward traditional weaving, which causes a reduction in the number of weavers. [5]. Handloom weaving is an inheritable vocation, and the new generation of weavers is still following the traditional methods of designing and production because of a lack of awareness, exposure, and knowledge about the latest technology and its possible applications. Because of this, the job of the weavers remains tedious, and production capacity remains low. Hence, this demographic has to face more competition from the inexpensive products available in the market that are superior in quality and are available in large quantities. [6]

Even though the power looms are unable to replicate the uniqueness and versatility of handloom designs, they are efficient enough to make close copies that can't be distinguished from the original by an untrained eye, which allows the shopkeeper to sell power loom products under the name of handloom. Moreover, power loom products are quite inexpensive compared to handloom products, which further decreases their demand in the market. [7]. The handloom industry is strong when it can produce goods in volume enough to meet the demand in the market, while at the same time keeping up with the latest fashion trends and constantly producing new designs that can't be replicated by the power looms. For this, the industry needs support from the government in terms of funds and technology to produce better designs quickly. Also, this industry required a boost from marketing by using new fabrics and commercially viable products that are widely accepted in the market. [8]

The development of pre-and post-loom processes is imperative to improving the quality of handwoven articles. Along with innovative techniques to speed up the weaving process, the embedding of the latest technology to increase the efficiency of weavers and their looms is required to make handloom more profitable in the competitive market. [9]

The products of handlooms are known for being unique, less capital-intensive, and eco-friendly in terms of energy usage and the use of sustainable raw materials. The flexibility of small production, quick adaptability to the demands of the market, and the malleability to adopt new and innovative designs while preserving the traditions and taking them forward are the biggest strengths of the handloom sector. However, this sector also faces many challenges and immense pressure from the competition it gets from the price-aggressive power-loom industry, along with the pressure of performing in terms of skill and aesthetics, present-day methods, infrastructure, supply chain, and publicity. [10]

III. INDIAN HANDLOOM INDUSTRY

In the 1990s, the major share of textile production (excluding hosiery, khadi, and wool) was from power looms, i.e., 66 percent, whereas handlooms accounted for 22 percent. In the 2000s, the shares of power looms and handlooms increased to 72 and 23, respectively, but the share of the mill sector decreased. Throughout the period 2009–2017, the shares of the power loom, handloom, and mill sectors remained constant, i.e., nearly 80 percent, 15 percent, and 5 percent respectively. [4]

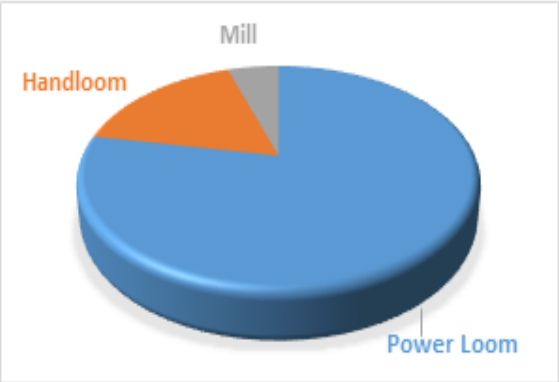

Fig. 1. Sector-Wise Share of Textile

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Table: 1. Textile Production in India During the Period 2009-2017 (Billion Square Meters)

Year	Mill		Handloom		Power Loom		Total Cloth*
	Values	% of the share	Values	% of the share	Values	% of the share	
1990-91	2.59	12.8	4.29	21.23	13.35	65.97	20.23
2000-01	1.67	5.06	7.51	22.76	23.8	72.18	32.98
2009-10	2.02	4.41	6.81	14.86	37	80.75	45.82
2010-11	2.21	4.69	6.91	14.66	38.02	80.67	47.13
2011-12	2.31	4.95	6.9	14.79	37.45	80.26	46.66
2012-13	2.42	5.1	6.95	14.66	38.04	80.24	47.41
2013-14	2.53	5.45	7.1	15.29	36.79	79.24	46.43
2014-15	2.49	5.25	7.2	15.18	37.75	79.57	47.44
2015-16	2.32	4.94	7.64	16.28	36.98	78.78	46.94
2016-17	2.26	4.92	8.01	17.44	35.67	77.64	45.94

(Source: Office of the Textile Commissioner, Government of India), *In total cloth production, hosiery, khadi, and wool have not been considered

The chart reveals that nearly the same percentages of cloth production came from different sectors: 78 percent from power looms, 17 percent from handlooms, and 5 percent from mills in the year 2016–17. [4]. Fiber is the basic building block for textile goods. The process of weaving starts with the fiber then the fiber converts into yarn or fabric through various intermediate stages. The time-consuming and labor-intensive tasks in handloom weaving can be categorized into two broad categories. The first one is concerned with the preparatory process, and the second one is concerned with the weaving. The preparatory process is mostly responsible for consuming a lot of time during fabric production in handloom weaving. Fig. 2 shows the various preparatory processes of handloom weaving. Handloom artisans use conventional methods for the preparatory process, which is very time-consuming. The time consumed in the preparatory process is approximately 65%–70% of the total time for fabric production. The most significant preparatory processes are motif design and graph making (30%–40% of total production time), which not only consume a lot of time but also play a significant role in adding more value to the product. The handloom products are identified by their intricate designs and color schemes, which cannot be replicated with a power loom. The designing process can be optimized by providing easily accessible and affordable technology as per the requirements of handloom artisans.

Fig 2: Preparatory for Handloom

IV. MARKET RESEARCH

CAD in textile design is not a new technology, but till now it has been far from the approach of the grass-roots artisans of India. There are numerous CAD solutions on the market that meet the various needs of literate or educated users. The CAD manufacturers targeted a wider area or a larger user group segment (who have the potential to afford the technology) for the development of tools in the software.

Some CAD Experts in the industry identified minor challenges of CAD applications in apparel manufacturing. (Adwoa et al., 2013)

i. The prices of some of the most common CAD applications, such as Page CAD, QCAD, Libre CAD, and Open SCAD, are higher.
ii. CAD operators must upgrade their skills to keep up with the latest CAD software.
iii. Finding a professional operator to run CAD software can be difficult at times. [11]

Some of the widely used CAD/CAM systems are NedGraphics (Texcelle/Jacquard Pro), CadVantage Win Jacquard, LECTRA (PrimaVision Weave), Pointcarré, Arahne (Arah Weave), Tukatech (TukaStudio), etc. However, MS Paint in MS Windows is used as the default drawing accessory for simple jacquard graph designing software to prepare graph designs [12].

V. TECHNOLOGY DEVELOPED

The Digital India Corporation (DIC) under the Ministry of Electronics & Information Technology, has been working for many years to understand the needs of artisans and develop digital solutions based on their usability. The work also acts as a bridge between the developed technologies and grass-roots user communities through user-oriented solutions and training for the community.

From the field experiences in various projects and the knowledge acquired about the constraints of the available affordable technologies in the market, DIC took the initiative to develop an open-source CAD software for a textile design that caters to all design-oriented functionalities of handloom weaving.

In recent years, Digital India Corporation has developed an open-source CAD software "DigiBunai™" (https://digibunai.dic.gov.in) for textile design. The base of development is the many product design requirements received from Indian handloom artisans to produce their region-specific woven products. The development started with the intricate designing skills of handloom artisans in Varanasi. Now, 4600+ beneficiaries/users of the technology exist in various states and have been successfully deployed in 73 textile institutes and training centers in India (till February 2023). The software has a complete package to satisfy not only the needs of handloom designers but also those of handloom weavers and pattern card punchers.

The software has different modules to cater to the various needs of handloom artisans to create weave patterns, motifs/artwork, as well as visualize the fabrics. These modules have multiple functionalities to perform various design-oriented tasks in a quick and user-friendly manner. The interface of the functions within and between the modules is organized holistically as per the workings of traditional artisans in the Indian handloom industry.

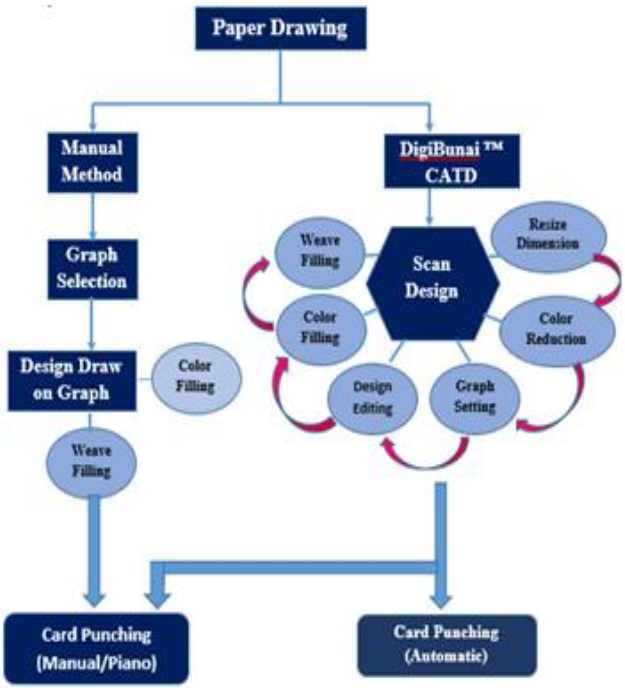

Fig. 3. Design Flow (Manual vs DigiBunai™)

A. Dobby Weave

This module is specifically used to design the fabric based on weave patterns. This module is a workable platform to create weave patterns, auto drafts, lifts, treadles, tie-ups, edit provisions for weave and yarn, fabric visuals, colorways, and double-layered fabric. It has the provision to export and print the creations with constructional parameters in the form of a technical sheet.

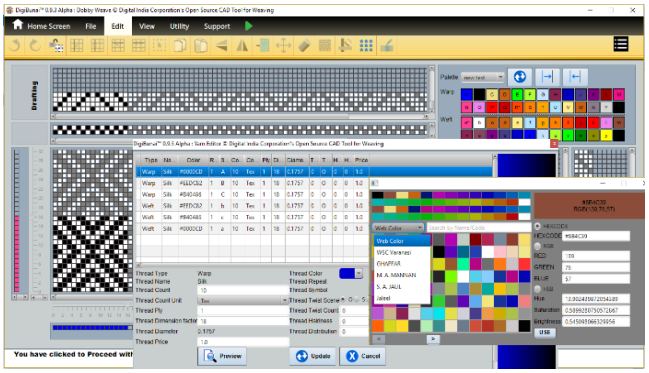

Fig. 4. Dobby Interface of DigiBunai™

B. Artwork Designer

As the name suggests, this segment is used to design or refine the motif or artwork. The functions incorporated here include resizing, hooks, density, color reduction, graph editing, weave filling, and punch file for design cards. The module is used to convert the artwork into workable jacquard designs by using weave-fill provisions at different places in the artwork. The filling of weave patterns provides strength as well as improves the aesthetics of the woven fabric.

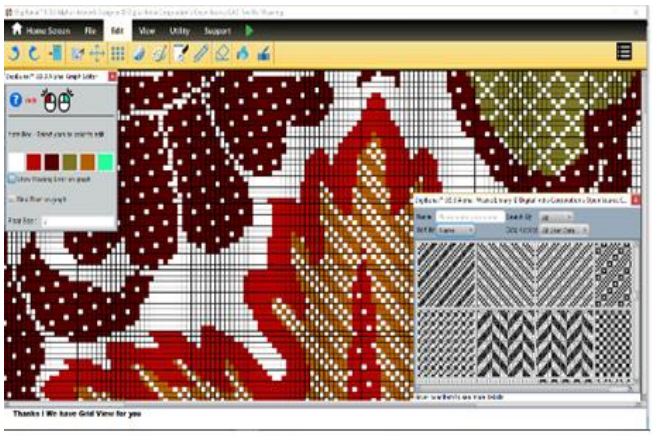

Fig. 5. Artwork Designer in Graph Mode

C. Fabric Creator

This module is used to simulate the fabric by using refined artwork with various editing provisions in the yarn properties like color, count, density, and design repeats. It also has the provision to weave the design with an extra warp or extra weft. The consumption of the yarns for weaving is calculated automatically by the user-defined construction parameters for fabric. When the user designs the fabric in the software based on input parameters that are similar to the physical parameters of weaving, the software offers the facility to combine the whole creation of different modules to create a layout of the garment. It is a two-way process or access facility, which means the created artifacts can be modified from the initial product to the end product and vice versa. In the Garment Creator module, the user can edit the yarn parameters as well as the orientation of the design based on a suitable appearance in the final product. It has also the functionality to select the predefined templates of the product or customize them according to the product.

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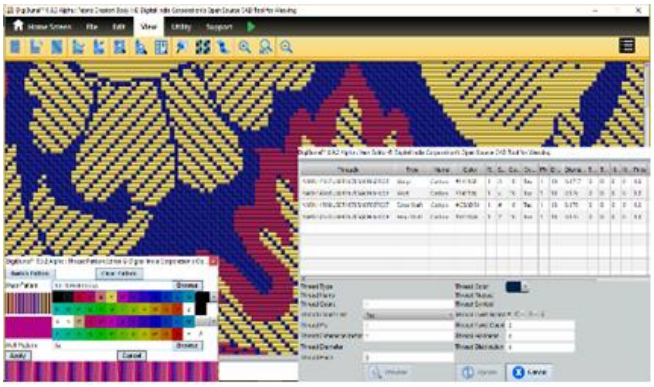

Fig. 6. Simulated Fabric in DigiBunai™ CATD

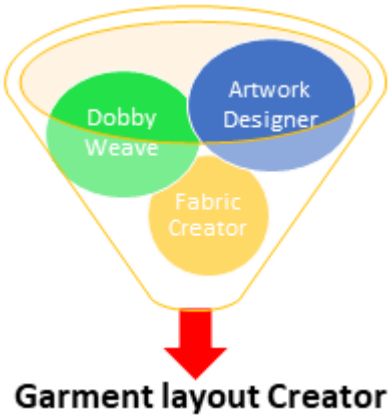

Fig. 7. Data used of modules in Garment Creator

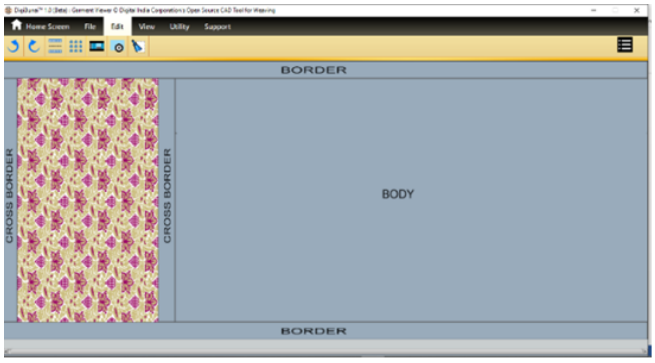

Fig. 8. Saree Template in Garment Viewer

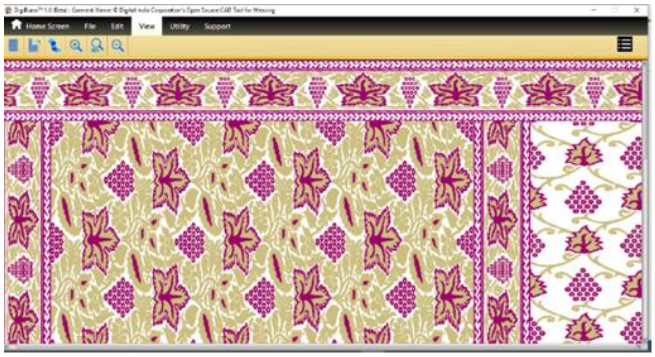

Fig. 9. Digital Fabrics placed in Saree Template

This module also has an interface to edit the fabrics on the fabric creator and place the edited file again to create the layout. After designing the whole layout of the product, the user can save the layout in the library of the module or export the image file with the construction parameters of the product. The facility to see the complete product layout before production eliminates the wastage of time and material.

Apart from the design modules (Dobby Weave, Artwork Designer, Fabric Creator, and Garment Viewer), it is available in 7 languages (English, Hindi, and 5 Indian region-specific languages) and has a multilingual framework to customize the software terminology in user-defined languages. The software also has functions to convert the count from direct to indirect units or vice versa. We can also calculate the GSM of the final fabric. It facilities multi-user support, which means multiple users can operate the software on a single system through their separate registrations in the software. There are security provisions inbuilt for data protection that restrict access from the other account.

Fig. 10. Garment Layout (Saree)

VI. RESULT AND DISCUSSION

The developed software performed well to suffice the end-to-end functionality that required handloom designers or weavers to design their products. Several available options like Design Graph Editing, Repeat visualization, Weave Editing, Fabric Simulation, Yarn Editing, Garment designing, Multilingual Framework, etc. are useful to transform the Manual Skills into Digital Skills of a Handloom Artisan. Predicting before the production through the application can eliminate the wastage of material for sample production as well as save time for production.

VII. CONCLUSION

As per the information summarized about the developed technology, this technology is designed concerning the requirements and understanding of handloom weavers or artisans, so this is easy to use for the preparatory design work of handloom weaving. The various modules in the software provide complete functionalities to optimize the design work of woven products. It will reduce the production time as well as the cost of the handloom products and produce defect-free fabrics. Since the technology is open-source software and readily available on the portal, it is easily accessible by handloom artisans. The portal provides complete information about how to use and develop the design digitally. The DigiBunai™ computer-aided textile design software hits the three pillars of technology accessibility, affordability, and usability to enhance the skills of handloom weavers and artisans. The developed software will become a milestone in supporting handloom weavers and preserving the Indian traditional art of handloom weaving.

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AUTHORS PROFILE

Ashish Dochania was born in Rajasthan, India, on September 2, 1984. He is BE and MTech in Textile Technology with more than 11 years' experience in the textile sector including yarn spinning, weaving, and designing (especially the development of textile CAD). He is currently working at Digital India Corporation, under the aegis of the Ministry of Electronics & Information Technology. He is working as a project coordinator to develop ICT-based solutions to support the weavers and designers. He is involved in project-related work for application development, functional testing, deployment, training of trainers (TOT), training of assessors (TOA), and building awareness of the developed technologies. He is also involved in futuristic work related to the enhancement of existing functions and the development of new features based on the requirements of grassroots users.