INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Ergonomics Design intervention to reduce manual effort of Kolhapuri crafted footwear manufacturing without affecting the craftsmanship.

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SHORT ABSTRACT

The footwear industry is an important segment of leather industry. Footwear industry is distributed in various parts of India. India ranks second among the footwear manufacturing countries next to China. The footwear manufacturing occupies a place of significance in Indian economy in view of its huge potential for employment, development and exports. The category of footwear industry is divided into two major halves. One is organized and other is unorganized, mainly craft based which has lot of varieties. Among them (craft based), Kolhapuri crafted footwear is prominent in Kolhapur, Maharashtra, western part of India. This particular craft has very significant presence in local economy as well as national economy (export and domestic market). This is a cottage based industry and mainly whole family involved in this craft based business. But the wellbeing of the Kolhapuri crafted footwear manufacturing artisans and their productivity is highly compromised due to various reasons. This crafted footwear production process involves various labor-intensive activities such as bottom sole making, skiving, punching, polishing, pattern cutting, heel attachment, upper strip preparation, stitching, finishing and final assembling. All these activities are divided among male and female workers of the house according to the heaviness of job types. Female workers are mostly involved in stitching, Veni (braid of leather) making, decoration and accessory preparation.

During field visit it was observed that all manufacturing operations in this industry are manual. Apparently it was observed that there is an inconsistency between operator's physical competencies and demands of physical task to operate tools/equipment which may leads to poor performance, low productivity and safety problems. While doing these various jobs artisans occupy apparently various non-optimal postures which may lead to development of occupational disorders. Further it was identified due to various reasons existing artisans are no more interested in their ancient craft business/profession. Based on field observation, discussion with various stakeholders of this craft, importance of its presence in national economy and detailed literature review, a need was felt to understand the whole manufacturing process in detail. Apart from this there was a need to study the involved tools/equipment, status of occupational health and any other intervention if required. It was identified in literature that effective

solution/intervention leads to improved efficiency, productivity and wellbeing of the artisans. Therefore it was expected that any intervention may inspire them to get back into this profession.

In view of the above a holistic process of design intervention to improve work techniques, tools and equipment for Kolhapuri crafted footwear manufacturing was taken as an approach. Present research focused on ergonomics design intervention to reduce manual effort of Kolhapuri footwear manufacturing without affecting the craftsmanship.

The present thesis was carried out in major three segments. Objective of the first segment of the study was to understand their working environment, identification of bottlenecks based on the severity of problems. This part explained ground level scenario which leads to an understanding of working conditions, current trend, manufacturing process, supply chain (from the production house to retail market), distribution of skill requirement in whole manufacturing process, scope of automation/semi-automation, used tools/equipment, price structure etc.

In this segment it was identified that working postures was not conducive for any workstations. Involvement of high manual and physical labor was one of the major concerned factors which may lead to decreased productivity, quality and increased material loss, rework, scrap, injury etc. Result of stakeholder's interview revealed 'loss of interest in their ancient craft business/profession' is one of the results of above identified factors. The whole manufacturing process was further distributed on the basis of skill dependency and possibility of operational intervention. The result showed that most of the tasks were skill dependent except skiving operation and sole & strip cutting operation has a scope of operational intervention. Further it was identified that sole & strip cutting operation requires more manual effort. Based on the above result sole & strip cutting operation were considered for technical operational intervention. Posture analysis revealed stitching and accessories preparation workstation may have scope of intervention although, intervention should not hamper the basic technical movement of the job.

In the second segment all varieties of interventions were conceptualized, screened and developed. Sole and strip cutting operation is being carried out by a traditional cutting hand tool called rappi (sharp edged tool). The used material in sole & strip making is leather (bullock, buffalo, cow and goat). Required hand force for sole & strip cutting operation were measured and found to be around 5 to 6 Kg which is quite difficult to produce manually during every cutting operation. The identified leather for manufacturing process was bullock, buffalo, and cow. Among all buffalo leather was found to be highest in strength. Therefore all cutting operation interventions were designed keeping buffalo leather in consideration. Sole cutting operation involves base and heel cutting. The challenge in existing sole making process was required high manual effort and keeping identical sizes in every production. In this research high manual effort was taken care by automated sole cutting machine and identical size preparation was taken care by cutting die. Both base & heel profile making were taken separately for design development. Both base and heel dies were designed using mild steel (EN8) and tested for its strength. While testing the dies in actual it was anticipated that in the long run of use there is a possibility of deformation in the die. This phenomenon may affect the whole process, quality, required force exertion, etc. Therefore a new iteration was generated, produced and tested. Test results revealed quality improvement in cutting operation as well as time reduction.

To operate the cutting die there was a need to develop a mechanism which can create sufficient pressure in controlled manner on the surface of dies so that dies can cut any leather. To achieve that, various designs were conceptualized and screened through Pugh chart. Various features of the design were identified based on the context of the application, availability of space, required quality & accuracy, time constraint, responses from craftsmen, etc. The required features were compactness, leather cutting effectiveness, manual effort reduction, rate of cutting, easy handling, maintenance cost. The concept which received highest score was manufactured physically and tested with newly designed dies for actual sole cutting operation. For strip cutting operation similar method was

adopted and dies were prepared. Both sole & strip cutting operation were tested in terms of quality, production of identical shape, accuracy, required time & manual effort etc. All found to be satisfactory in actual.

From the first segment of the study it was also found that Veni (braid) making and accessories preparation require intervention but there is less scope of operational modification as these are highly skill based jobs and has significant impact on the essence of specific craft. After field observation, analysis of interviews with stakeholders, it was concluded that postural stress relief by design modification of workstation may alter (improve) physical load. Keeping that in mind both the workstations were virtually conceptualized, designed and tested for various ergonomics parameters. The result revealed a satisfactory improvement in postural load which may in turn enhance performance, well-being productivity, quality etc.

The final segment dedicated to evaluate impact of all varieties of interventions for up-liftment of this specific craft, way out to disseminate the outcome of research towards specific community. After understanding all the interventions in terms of operational involvement, functionality, operative procedure, space requirement, its impact on the essence of craft, quality and quantity of the product, productivity, the efficiency of workers, personal comfort, cost involvement, etc. was analyzed. In this part various workshops were conducted for stakeholders. Responses through unstructured interviews and discussion from various stakeholders were recorded. Content analysis of those responses revealed satisfactory results of all these interventions. Cost benefit analysis of major operational changes were also calculated and described to the stakeholders for their easy understanding and acceptance. 'Sharing of major facilities holding under one roof' was introduced to the stakeholder especially young enthusiast for encouraging them to continue their own ancient glorified business/profession.

The whole study depicted a holistic approach to enhance productivity, process, quality of Kolhapuri crafted footwear manufacturing whereas, human health in terms of occupational health was major consideration of the interventions. After implementation of all interventions, there was no impact in the main essence of this specific craft, which is remarkable contribution for any crafted product and handcraft industry. Therefore this methodology can be set as a benchmark for any such intervention for any improvement in craft based industries. Also designers can take this approach for any other relevant product design for this handcrafted industry.