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Socio-cognitive Impact of Artifact Replacement
The Curious Case of Amritsar Hand-Knotted Carpet Weaving in India

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Article abstract

What happens when an artifact gets replaced by another artifact in a practice? In what respects, this artifact replacement impacts users, tasks and practice? This paper discusses socio-cognitive impact of artifact replacement in Indian native craft practice, Amritsar carpet-weaving which used a code-based design representation (talim) till few decades ago which it inherited from its historical cousin Kashmiri carpet-weaving. However, this DR got replaced with a graph-based DR called naksha around India's partition in 1947. The cognitive impact of this replaced artifact on users in information retrieval, team communication and coordination, and social impact in terms of design creativity of industry is reported. The paper emphasizes including historical analysis of artifact-evolution over time and their impact on user-interaction while analysing artifacts so that one may go beyond giving static snapshots of their current profiles and associations.

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Introduction: Lacking Historical Aspect in Artifact Analysis

The current studies related to artifact analyses in domains like design, organizational, and management studies usually provide a static snapshot of an artifact with respect to its categories, functions, varieties and user engagements in a practice (Nomura et al 2006; Gurses et al. 2009; Heersmink 2013). These analyses fall short of revealing how users' engagement patterns with their artifacts came to be in the first place. This is because an artifact does not exist as a static entity in a practice, but co-evolves with its users, their tasks, and goals. The theorists in Cultural-Historical Activity Theory (Leontiev 1979; Engestrom 1987) and Situated-Distributed Cognition (Baber 2003, 2006; Hutchins 1999, Lave 1988; Suchman 2007; Osiurak et al. 2018; Woods 1998) have long championed the co-evolvement of artifact-task-practice-cognition couplings and inspired approaches like social construction of technology (SCOT) and Human-Artifact Model (Bodker and Klokmose 2011) for studying artifact development (Pinch and Bijker 1987; Bijker & Law 1992), artifacts-in-use (Bannon & Bodker 1991;

Quennerstedt et al. 2011) and artifact appropriation (Dourish 2003). In this literature, the least studied aspect is *artifact replacement* whereby one artifact completely replaces another artifact in its ecology. A theme that has come closest to this aspect is *artifact substitution*, whereby a new artifact substitutes an older one, but does not completely pushes the older artifact out of its ecology (Brodersen et al 2007). The current paper reports a case of *artifact replacement* in the practice of Amritsar carpet-weaving in India.

Amritsar carpet-weaving (ACW) has its roots in Kashmiri carpet-weaving (KCW) which is undertaken in the adjacent region of Kashmir, both in India, from which ACW inherited its technique and artifacts around the 1840s. Artifacts in a practice constitute any physical device, representation, tool, or document with which users can store and communicate information (Kirsh 2010, Hutchins 1995), facilitate collaboration (Hindmarsh and Heath 2000), coordinate their joint activities (Nomura et al 2006), enhance their planning and location awareness (Bardram and Bossen 2005), establish roles and hierarchies, enable

learning (Kafai 1996), structure the practice in turn (Hutchins 1995) and foster collective memory and cultural identity (Hutchins 1995; Heersmink 2021). ACW presents a unique case wherein due to technological needs of artisans in the aftermath of the Partition of India in 1947, *naksha*, replaced *talim*, the central artifact of the practice, over the course of a few years. *Naksha* is a grid-based design representation on which the design to be woven is drawn. In Kashmir, from a *naksha*, a symbolic script, called *talim*, is generated which the weavers read to weave the design (Kaur 2017). This *talim* completely disappeared from ACW post-1947 and was replaced by *naksha* which weavers started reading to weave their carpets. Before 1947, the Indian craft sector had experienced diverse technological changes like newer kinds of looms (Roy 2005) and increasing use of synthetic dyes (Mukund 1992; Roy 2004) caused by de-industrialization due to British industrial growth (Bagchi 1976), provision of new tools by government agencies (Bagchi 1976), and the motivation of profit for artisan capitalists (Roy 2020, 113). The colonial pressures thus extended the British political authority over textile and craft production (Mukund 1992). In this scenario, ACW presents a case where the impact of a political event, i.e. partition of the country in 1947, caused a direct technological change in the production process. In this impact, the central artifact of ACW, *talim*, was replaced by *naksha* in a short span of a few years to meet the technological needs of artisans. The longstanding socio-cognitive impact of this replacement, on the remaining artifact ecology of ACW, is reported in the present paper. In empirical studies related to artifact analysis, where artifact ecologies have primarily been studied in

corporate organizations (Dourish 2003), hospitals (Cormi et al 2022), academic settings (Belin & Prié 2012; Vasiliou et al 2017), volunteer-based communities (Bodker et al 2016), people's nomadic (Rossitto et al 2014), mobile (Jarrahi et al 2017), and smart work practices (Ko et al 2021), this study has come from the craft domain.

The Study: Connecting Kashmir and Amritsar

This study, ongoing since 2015, is on situated and distributed cognitive processes in Kashmiri carpet weaving (KCW) in India with special reference to a cryptographic system used in the practice. The study has been undertaken in Srinagar in the northern-most state of Kashmir using cognitive ethnographic methods with fieldwork spanning over 2.2 years from 2015–2018, including month-long studies in 2021 and 2023. Short periods of fieldwork in Amritsar, in the adjacent state of Punjab, were done in 2015 and 2019. KCW has three task contexts: *designing*, wherein designs are either created digitally via a CAD system or are manually drawn on graph-sheets (Kaur 2017) and colour-schemes are assigned via symbolic codes by designers (*naqash*); *coding*, wherein a cryptic script called *talim* is generated from these encoded graphs and written on long rolls of paper by code-writers *(talim-guru)* [1]; and *weaving*, wherein *talim* is read, decoded, interpreted and communicated by weavers (*kaalbaaf*) in an equally cryptic trade-language among their teams to weave the designs (Kaur 2020). The central artifact of KCW is, thus, *talim* (figure 1) whose structure has altered considerably since first documented by British linguist G. W. Leitner (1882) (Kaur 2017). Adjacent to Kashmir

Figure 1
A typical Talim Roll. Courtesy of BMW Designers, Srinagar (Kashmir)
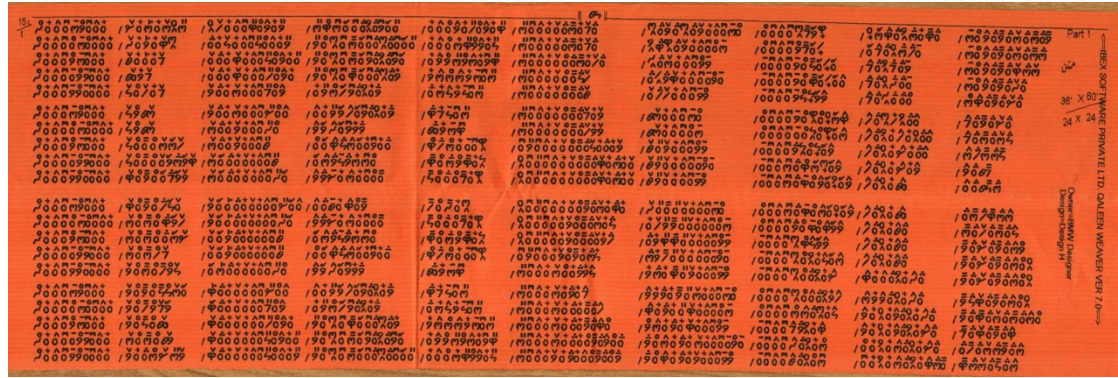
is Punjab, whose border city Amritsar has long been eulogized for weaving the finest pile carpets (Gazetteer of Amritsar 1883-84; Mukharji 1883; Watt & Brown 1903). Large-scale famine-induced migration of Kashmiri artisans around the 1840s first initiated the shawl and then pile-carpet weaving at Amritsar. These migrating artisans brought with them the techniques and artifacts of KCW to Amritsar (Hawley 1913, 255; Chattopadhyay 1970, 23; Eiland 1979, 166) including *talim*. From Henry Baden Powell's (1872, 26) brief mentioning of 'reading-out' patterns in Punjab carpet-weaving, we get the first detailed documentation of *talim*'s use in ACW by Lewis Mumford who mentions a "book" in which are "written down in Kashmiri characters all the stitches in each section, with the colors, and the exact sequence in which they must be put in" which is read-off by "a boy" specially assigned to this task (1900, 261). This "book" is none other than *talim*. At the turn of the 20th century, Eliza Ruhamah Scidmore notes how the pattern written in "Kashmir cipher" is called out by a reader and is followed by young boys working on the loom (1903, 309). This *talim*, "*taalim tereh,*" "*raqsha kitab,*" or "book of the pattern," is generated either "from the actual carpet to be copied, or from the ruled

section paper drawing" indicating a reverse-information flow whereby *talim* is generated from an existing carpet (Harris 1908, 60). Its usual generation from a graph-drawing is confirmed by Bipin K Sinha (1926, 486) and later by Murray L. Eiland Jr. & Murray III Eiland as they note, "weaving in Kashmir (as well as Amritsar) proceeds by the talim system" (1973, 298).

These sources provide ample evidence that *talim* originated out of Kashmir and was used in ACW after the 1840s and we continue to get scholarly references of its use until Sinha's 1926 observations. A conflicting picture from 1979 onward appears, however, as Eiland & Eiland note that "weaving in Kashmir (as well as Amritsar) proceed by *talim* system" (1973, 298), but four years later, the first author Murray L. Eiland contradicts his earlier claim, stating now that, "Amritsar also was long unique (aside from Kashmir) in India in using the *talim* system … During the last several decades, this system has slowly been replaced by scale paper drawings" (Eiland 1979, 166). By 2001, *talim* was again claimed to be "widely used" in the "knotted carpet industry in Kashmir

and Punjab" by Peter Harris contributing to the already chequered history of scholarly treatment of *talim* in ACW (2001, 1).[2] Before we delve into *talim*'s eventual fate in ACW, a brief introduction to the practice:

Amritsar carpets: Amritsar carpets, handwoven in the district of Amritsar in Punjab (India), are wool-on-cotton, carpets of around 100 knots per square inch (kpsi) (figure 2). This 'knottage,' understood as the 'quality' of the carpet, is represented as *columns x rows*, e.g. a 7x13 quality carpet has 91 kpsi. In ACW, generally repetitive patterns like Bokhara are woven, wherein a single motif such as a box woven in five to six colours is repeated throughout the carpet. Like other cottage industries, ACW is dominated by the manufacturer, who acts as a primary decision-maker. Sourcing designs from freelance designers, they commission carpet to household weavers, providing them with loom, tools, raw material and design. Once the carpet is woven, the manufacturer takes it off the loom, and lays the warp for the new carpet. Weavers are paid piece-rate wages, usually partly in advance, while the rest is paid on completion. While weavers generally earn 3500 INR for a 4x6-foot carpet, taking them a month to weave, designers earn 1500 INR for small-size designs requiring a few days of labour.[3] Despite being paid slightly more than weavers vis-à-vis their time spent and effort, there is a significant dearth of designers in ACW. No more than two designers in the whole region could be found during my fieldwork, one of whom had retired recently (aD2 – Male, 74y) and the other (aD1 – M, 54y) was the creator of the principal pattern currently being woven at site. At present, only manual designing, involving design

creation on graph sheets, is being done with the exception of one manufacturer who sources digital designs from outside Amritsar.

Figure 2
Map of India showing Srinagar and Amritsar in northern-most states. Courtesy of Nationsonline.

Task structure: ACW has two task contexts: designing and weaving having a linear information-flow from one to the other. In the design phase, the designer draws the design, without colours, on graph-paper and fills the cells pertaining to motif-outlines with a sketch pen. This black and white design is called the 'master-copy' from which further copies, as and when needed, are reproduced. The colours are added to the design later and the colour-designed graph, called *naksha,* is given to the weavers to be read for weaving.

Tools and artifacts: The weavers use a vertical loom with two wooden rollers with cotton-warp stretched between them (figure 3). They sit on a bench

around 1-foot high on the side facing the rollers. A wooden strip *(panakh)* (figure 3b) is fixed to the carpet on the loom's backside, and it is adjusted every few days as the woven carpet rolls over the lower roller. The weavers access yarn by pulling it from the top of the loom, while unused yarn-rolls either lie on the floor at the loom's backside or are casually hang over the loom's side-beams. The weavers follow their *naksha* without looking at it. Usually, it is preserved under their sitting-bench cover, or in some basket kept nearby, or in some other room.

The design representation: The *naksha* is a typical design "transference device" (Davis, 1972, 7) used in weaving practices like that of Agra in India (Schuster 2008), Tibet (O'Neill 1999), Nepal (Goswami, 2009, 193), Iran/Persia, etc. (Topalbekirog et al 2005). In ACW, *naksha's* quality varies as per its grid-size, e.g., a grid-block measuring 1.25 inches-square in a 10x16 graph-sheet comprises 160 cells in 10 columns and 16 rows. A typical graph sheet is comprised of rows and columns, where these rows and columns are further organized into blocks (grid-block), e.g. a 20x20 graph means its one grid-block has 20 rows and 20

Figures 3a (Left) and 3b (Right)
Front and backside of Amritsari loom. Contrast the sitting position of weavers with sitting position of weavers in Kashmiri carpet weaving in figure 4.

Figure 4
In KCW, weavers sit on backside of the loom while lower rollers point towards the other side. In ACW (figure 3), weavers sit on the side facing the rollers.

columns.[4] The quality of graphs in ACW has altered over the years with 16x16 graphs being used in the 1980s and 10x18 graphs being used from 2000 onwards, which further reduced to the 10x16, 9x16 and 8x17 grid-graphs being used at present, showing decreasing columns in the grid-block measuring an inch. This reduction is often compared with a corresponding decrease in the carpet's quality/knottage over these years. K. K. Goswami remarks that, "The quality of

the graph paper will vary, depending on the complexity of the design, particularly the number of knots or tufts per square inch" (2009, 199). The carpet-knottage and graph-quality relation is not this rigid, however, as any knottage can be designed on any graph. Figure 5 shows an 8x16 knottage-design (128 kpsi) drawn on 10x18 quality-graph (180 cells to an inch) designed in 2014. This becomes possible because a graph is just a representation and any graph can accommodate any knottage for which all that the designer needs is the required computation to work out the design area (Kaur 2018).

Patterns: In ACW, generally the Bokhara pattern is woven, wherein a single motif or a floral-box is repeated throughout the carpet. In this category, the leading design currently being woven is called *parda* (curtain) in which a cup-resembling motif is repeated throughout the carpet giving a semblance of a curtain (figure 5). This cup-resembling motif is of a fixed dimension and is woven in 19x19 rows and columns, in black colour, taking shape beginning with the nineth column in the first row. Due to its fixed dimension, the motif does not alter its size even in larger carpet-sizes where only its frequency increases and an additional border, resembling the border on the sides, is repeated in the middle of the carpet, which bifurcates the whole design into two equal windows in which these cups are repeated. Around 6 colours are usually woven in *parda* pattern: black is used for the motif outline, another colour for the carpet-background, and the remaining colours for other smaller motifs in the borders.

Figure 5
Naksha **showing** *parda* **pattern. Courtesy of Rajwant Singh, Amritsar.**

Methodology

During 2.2 years of fieldwork in Kashmir (India) from 2015–2019, work was also done in Amritsar (Punjab, India) which included visiting twenty-one villages near the border with Pakistan in the Ajnala block of Distt. Amritsar.[5] The snowballing method was used to identify villages and community members. Early on, it was clear that a mere visit to a village may or may not result in meeting the community as weavers had 'rapidly been uprooting their looms' (*khaddi putt dena*) over the past few years and shifting to seasonal agrarian jobs. Consequently, during my 2019 fieldwork, four villages were found to have only one functional loom, ten villages had two–three looms, one village had six looms, while three villages were found to have no looms at all. During fieldwork, unstructured interactions were undertaken with two designers (M, 64y avg. age), six manufacturers (M, 59y avg. age) and twenty-five weavers (incl. 12 females with 35.8y avg. age) excluding four teenage female household-weavers. The discussions primarily centred around their weaving/designing activities and

their usage of tools and representations to understand their strategies of information retrieval, team communication and coordination while recording these interactions wherever permitted. The interactions took place in Punjabi, the native language of both the researcher and respondents. To deeply understand the interplay between their design representation (*naksha*) and weaving, a month-long cognitive ethnography was done at a *karkhana* (factory) in the village Rajasansi, which, being the forerunner of carpet weaving, acted as a guiding source of patterns, material, and marketing in the region. This *karkhana* was housed in a poorly built shed with window-holes on the upper portion of one wall. It had nine looms placed in two rows irrespective of the direction of light falling on them. To compensate for an otherwise dark hall, a 60w bulb, dangling from ceiling, was fixed in the middle. Among those nine looms, five were functional on which eight male weavers (46.25y avg. age with exp. avg. 28.12y) wove medium to large size carpets in *parda* pattern. A daily video-recording of their activities from warp-laying to weaving on two looms with four weavers was done for a month in 2019.

Besides this, an archive of designs beginning in 1975 was created to understand developments in graphing and design over the years. The claims regarding the use of *talim* in ACW, as was made in the literature discussed in section two, were verified with field observations and community interactions during which, a researcher-generated sample *talim* was shown to respondents to see how familiar they were with it; had they seen or heard about it being used, or could they figure out its logic? The fieldnotes and transcripts of these interactions were subjected to qualitative analysis and themes were generated that relate to representation-use, designs and patterns, actors' cognitive activities related to information retrieval, team coordination, and communication. This analysis led to the following findings.

Findings 1: Mis-information on *Talim*-use in Literature Post-1947: Case of Replacing of an Artifact (*talim*) by a New Artifact (*naksha*) in ACW

The observation of their activities and community interactions revealed no trace of *talim* in ACW, contrary to the claims made in the literature post-1947. At all looms in twenty-one villages, *naksha*, instead of *talim*, was found with weavers. As per the memory of my elderly respondents, *talim never existed in Amritsar at all*, let alone seen or used by them. No one admitted to even hearing about it, even in their childhood. As weaver aW19 (Female, 60y) said:

> aW19: I have been doing this work for many years … since childhood … for almost 35–40 years!

> Researcher: In all those years, have you ever seen *talim* like this or heard about it?

> aW19: No, I haven't seen … not even heard … I had a brother who used to make *nakshas* but he has grown old now … there was one more brother, GS, who also did the same work.

> Researcher: Could they know about it?

aW19: No, there is only *naksha*, which you have seen. We never saw or heard this kind of thing (referring to talim). [Translated from Punjabi to English]

Similar comments were made by others. The designer, aD2 (M, 74y), argued that even if *talim* existed, it, most probably, did before India's partition in 1947. His own experience dated back to 1965 when *naksha* was already prevalent. This conjecture aligns with Eiland's observation where he mentions, "During the last several *decades*, this system has *slowly been replaced by scale paper drawings*" (1979, 166, italics added). The word "decades" in this 1979 study roughly refers back to 1947 when India was partitioned into India and Pakistan dividing its northern states of Punjab and Kashmir. After Partition, while Amritsar remained on the Indian side, Lahore, about 30 miles from it, went to Pakistan. The Partition caused mass exodus and hugely impacted the demography, resources, industries, and trade on both sides. Carpet-weaving, including designing at Amritsar (Gazetteer of Amritsar 1883–84, 45) was chiefly carried by Muslim weavers (Gazetteer of Amritsar 1893, 114; Macfarquhar 1947; Raheel 1980), mostly by Kashmiris themselves (Gazetteer of Amritsar 1893, 116; Sheikh & Budh 2009, 85). The Partition caused large-scale migration of Muslims from Indian Punjab to Pakistan Punjab including the weaving community as Roy notes, "especially the *ustads*, emigrated from India to Lahore, Multan, and Lyallpur. The effect in Amritsar in particular was devastating" (2004, 228). Pakistan Carpet Manufacturers and Exporters Association (PCMEA), too, attributes Pakistan Punjabi weaving to

this migration: The manufacturing of carpets in Pakistan began in the same way as in India and when the country was separated from India most of the weavers, which were Muslims, moved to the Pakistani side (PCMEA). Resultantly, the industry, which employed around 5000 persons at the turn of 20th century, started declining around 1947. A sign of this decline, as per Roy was, "the relative rarity of young apprentices" (2004, 216–17). This migration might have caused a dearth of *talim*-writers at Amritsar without the possibility of their replenishment from the remaining population. This is because *talim*-writing requires nuanced literacy skills, including mathematics, which makes it different from the physical knot-tying skills required of a weaver, which could be locally replenished from allied industries like shawl-weaving, which had switched to carpet-weaving in the 1870s, or from the emigrated population from Pakistan. The lack of *talim*-writers would have forced designers to make decisions on which design representation to use: continue with existing *talims* encoding the old designs or stop using *talim* altogether and start communicating design information from the *naksha* itself. The latter solution was eventually adopted. This reduced the need and demand for *talim*-writers in the practice and led to the eventual disappearance of *talim* from ACW.

I admit that a deeper investigation of socio-political factors causing this situation is required. What is clear from available data, however, is that: 1) *talim was* used by the ACW community for which literary sources from section two are evidence, and 2) it *did* disappear from ACW post-1947 and was replaced by *naksha* as is evident from our current

observations. The socio-cognitive impact of this replacement can be gauged by comparing actors' current engagement patterns with *naksha* at Amritsar and with *talim* at Kashmir.

Findings 2: Cognitive Impact of New Artifact *Naksha:* On Practice and Users

As artifacts co-evolve and co-adapt with their users and tasks (Kirsh 2010), evolved/replaced artifacts, too, facilitate some tasks and cognitive processes at the cost of others (Raczaszek-Leonardi, et al. 2019, Hutchins 1999, 127) by limiting choices of action (Zhang and Norman 1994). Going by this, there should be some tasks facilitated by *talim* but not by *naksha*, and vice versa, though both are design representations evolved to achieve the same goal of representing and communicating design information to weavers and coordinating their weaving. In this context, the community interactions and *karkhana*-observations revealed following patterns in actors' cognitive activities:

1. Memory-based weaving

Despite *naksha* being present, weavers were found *not* to engage with it on any regular basis, rather, they rarely consulted *naksha* for weaving which was a surprising finding. The particularities of the design being woven were found to be the chief reason for this rare engagement. *Parda,* the most frequently woven design in ACW currently, has only one cup-motif repeated throughout the carpet. Its fixed dimensions and canonical colour (black) facilitate memorizing its details after which *naksha* becomes redundant for weavers. On the commissioning of a

new carpet, only the background colour is changed, for which weavers do not need to consult their *naksha* again. Even for weaving different sizes, they need only to figure out the number of motif-repetitions wherein the motif's fixed dimensions help and are often provided by their manufacturer as well. Thus, three factors facilitate design-memorization by weavers: motif repetition, its fixed dimension leading to its calculable frequency, and less colours. Together, these make *naksha* a redundant artifact and diminish its existence to a mere formality. Many household weavers, in fact, did not even have *naksha* with them. Those who had *naksha* with them, had it carefully stashed in their closets as something supplied by their manufacturer who had commissioned the carpet from them. This *naksha* is dug out occasionally by them to show to the visitors or novice-apprentices. Once, novices memorize the pattern, *naksha* becomes useless for them as well.

Thus, despite studies mentioning the existence of "scale-drawings" (Eiland 1979, 166) or "graph papers" (Bawa and Joseph 2010, 4) in ACW, the fact is that the actual practice is *not even* graph-based, but memory-based. There is a difference between actual mediation performed by a representation in an activity and its superficial existence. Mere existence of a representation in an activity does not establish its causal connection with that activity. For that to happen, the user must engage with that representation regularly so that it can act as a mediating link. In this context, ACW presents a case of a superficial or cosmetic representation, unlike a mediating representation like *talim* in Kashmiri carpet weaving (KCW), which is necessarily consulted by the

weavers there to weave the design (Kaur 2020).

2. Information representation and retrieval

Besides cup-based *parda,* repeating boxes are also woven in ACW wherein a floral box (*dabbi*) is repeated throughout the carpet. As per variations in internal foliage and/or colours, these boxed-patterns go by different names like *mohri dabbi, Afghani dabbi, Pakistani dabbi*, etc. In this *naksha*, one such box is drawn, while the number of repetitions of that box are either mentioned in the margins of that *naksha* (figure 6) or are conveyed verbally to the weavers. On encountering novel variations, weavers do consult *naksha* initially to know the basics of the repeating motif to be woven. In this consultation, graph-properties like grid-blocks were found to play a significant role. The cells of the *naksha* grid-block enable location identification and calculation of row/column/cells involved in the drawn motif. Simultaneously to this, depiction of single representative motif in the *naksha* restricts weaver's attention to a particular spot only. For example, the grid-block in figure 6 is of 9x16 rows/columns and has 160 cells, but it does not have any internal boundaries (as shown in third block of figure 7). Because of this, extracting information from even a single motif is difficult. In large sizes involving less repetition and novel motifs, the cognitive effort required for extracting information from such graphs increases significantly. A grid is a basic building block in a graph-based representation (Bokil 2012) but if it is not appropriately structured, it increases the cognitive effort of the graph-processor instead of facilitating his or her task (Kaur 2021). Due to this, a reluctance for novel patterns was found

among weavers in ACW. On being shown Kashmiri designs, almost all respondents admitted that it would be difficult to read *naksha* of curvilinear patterns like these due to their being extremely complex, though some admitted that they could weave it, but it would cost more, e.g. aM4 (M, 60) said,

> aM4: If its' *naksha* is given, we'll make it … but it will cost more. Naksha is difficult to read, and if designs are like those of Kashmiris, who draw so many flowers-and-petals, their *nakshas* would also be complex requiring more labour. We already don't get paid much. … manufacturer does not pay enough, so, what's use of making this one? [Translated from Punjabi to English]

3. Team communication

Since weavers actually engage in memory-based weaving, hardly any activity-related communication was observed among weaver-teams working on the same loom, e.g at the *karkhana*. When asked about novel patterns, teams preferred consulting *naksha* of those novel patterns individually or discussing them before weaving. While they admitted that one could call out the pattern from the *naksha* aloud to other weavers in principle, the system of reading out *naksha* had eroded a long time ago. Since they remembered the *parda*-pattern, which they had been weaving for the last 10–12 years, there was no need to read the *naksha* aloud. For demonstration purposes, however, *karkhana*-weavers performed the reading aloud of a *naksha* on one occasion and aspects of that were noted. The *naksha* of their loom was taken out of a closet in an

adjacent room and was read aloud by a weaver at loom-1. The reading consisted of largely disjointed phrases, e.g. "leave four, weave three," "weave five black," "weave seven blue," etc. Apart from this demonstration, no naturally occurring reading aloud of *naksha*, either at *karkhana* or at home-looms in villages, was observed. This contrasts completely with the engagement of *talim* in KCW where not only is it *necessarily* consulted, but it is read aloud like a text in an extremely rich, cryptic trade-language among the weaver teams. This reading aloud significantly transforms weavers' code-perception and facilitates team communication and coordination in KCW (Kaur 2020).

Figure 6
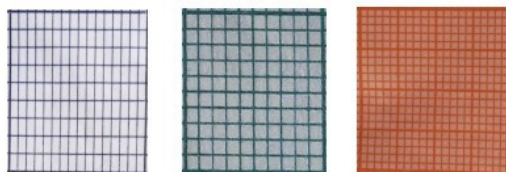**Afghani dabbi pattern. Courtesy of Rajwant Singh, Amritsar.**

Figure 7
Grid blocks in different graph representations. Image courtesy of the author.

4. Team coordination

Lack of communication among weaver teams in ACW was found to have a visible impact on coordinating the weavers' team activity. The coordination in team activities is achieved either explicitly by artifacts (Fiore & Wiltshire 2016; Andersen et al. 2002), representations (Garbis & Wærn 1999), material signals (Clark 2005), language (Fusaroli & Tylén 2012), or implicitly via monitoring team members' actions and anticipating their needs (Rico et al. 2011). Language and artifacts are important means of generating and maintaining workspace awareness (Gutwin & Greenberg 2004, 183) and both were absent in the weavers' teams in ACW since neither *naksha* nor its reading aloud mediated their joint activity. Weaving entirely from their memory, they required no information retrieval from others, making them work individually despite working with others on the same loom. This made them responsible only for *their* portion or territory on the loom. These territories were neither fixed nor clearly specified on the loom, impacting fair division of labour. Though some thread-markers were found on the loom, these were fixed during warp-laying to indicate threads fixed per feet. Beyond acting as memory-aides during that activity, these thread-markers were not taken advantage of by weavers, e.g. to divide their weaving area or territory on the loom and thereby coordinate their activity as is done in KCW (Kaur 2018). This internally disconnected weaving impacted their cohesion as a team where a speedily working weaver would need to wait until another weaver finished his portion. In one instance, a weaver wove only his portion on a loom at *karkhana* for many rows without touching the

other side as the weaver for that portion was absent during that period. This resulted in several inches of partial weaving on the loom. In contrast, KCW uses *talim* to coordinate a team's weaving, which, via its reading-aloud, ensures that no member weaves ahead or behind the instruction relayed during the reading aloud of *talim*. This further ensures that the team starts and finishes weaving the row at the same time and avoids partial weaving (Kaur 2018; Kaur 2020).

The above-mentioned patterns of engagement with *naksha* have impacted the cognitive profile of weavers in ACW. As artifacts and cognition co-evolve, the cognitive profile of users is impacted by the artifacts they use, whether these are their tools, representations, or language (Norman 1991; Hutchins 1999; Magnani 2007; Kirsh 2010). Minimal, irregular, and poor engagement with *naksha* has impacted not only the weaving of ACW weavers, but also its conceptualization by them, for example:

1. Low awareness regarding basics: The majority of weavers were found ignorant of the *whys* and *hows* of basic concepts of weaving even though they had been weaving for many years: e.g. when asked about the number of warp threads fixed on their loom most weavers could not provide a satisfactory answer. Being a basic question, one would expect that a weaver with many years of experience would know the number of warp threads fixed on their loom, but this was not the case. Two reasons were found accounting for this:

1.1 Non-participation in warp-laying: A direct way to obtain the information related to the number of warps is via warp-laying. Now, the warp is generally laid by the manufacturer, and not by weavers themselves, especially women-weavers who stay aloof from warp-laying, considering it a man's activity (*bandeyaan da kamm*). Only one weaver in the whole region, aW10 (M, 54y), was found to know warp-laying. In contrast, all *karkhana*-weavers knew it. The shared social settings have direct bearing in organizing people's work experiences (Kiesler and Cummings 2002) which let them stay updated. Working in a professional environment of *karkhana* where no specific division of labour between warp-layers and weavers existed, everyone was required to lay warp on his loom himself before starting a new carpet. This regular participation made them knowledgeable about the details of warp-laying.

1.2 Poor engagement with representation: Another way of getting warp information is via design representation which maps, one-to-one, with the loom structure, e.g. by counting the number of columns in the *naksha* one can know the number of warp-threads fixed on the loom. For Bokhara-style repetitive patterns, the total number of columns are multiplied with the number of repetitions to figure out the total number of warp-threads, while in other repetitive patterns, the column-total is doubled to get the eventual figure. This method, too, is not applied in ACW because weavers conduct memory-based weaving. For them, *naksha* is a repository of design information only and not something that corresponds with the loom structure. Because of this non-awareness about the correct and complete functionality of *naksha,* many weavers, even when hinted, were not able to extract the required information from their *naksha*. Likewise,

when asked about round carpets, the majority of them concluded that it was not possible to weave them from a rectangular graph-sheet, which, was possible according to *karkhana* weavers. This again shows the household weavers' limited conceptualization of *naksha* and its possibilities, as well as a disconnect from their practice's historicity. Round carpets have been regularly woven at Amritsar and its adjacent city, Lahore, in earlier times (Erdmann 1966, 199) just like they are woven in Kashmir today. In contrast, in KCW, any lay-weaver can tell the warp-number, even on the looms of others, due to their regular engagement with *talim* combined with the knowledge that it maps one-to-one with warp-threads that are fixed on the loom. As a result, they can subject *talim* to yield further information, e.g. the current row being woven, stage of design progression, number of knots in carpet, etc. (Kaur 2018).

2. Low-awareness about weaving: Besides basics, ACW weavers displayed low-awareness regarding other aspects of weaving, e.g. none of them could tell why weaving outlines of motifs is called *doing talim.* The reason for this is that ACW has retained this phrase from its Kashmiri-roots. Carpet-weaving is bifurcated into two weave actions: weaving motif-outlines first, while leaving gaps pertaining to their internal body and background for later weaving. Once all outlines are woven, the gaps are filled in later. In KCW, *talim*-reading gives indications of weaving outlines which are woven *simultaneously* to that reading-aloud, leaving other portions for later weaving. Once all outlines are woven, *talim* reading is stopped and gaps are woven silently by weavers (Kaur 2020). For of this reason,

weaving outlines is called *doing talim* in KCW. Thus, where KCW weavers could answer why weaving outlines is called *doing talim*, ACW weavers could not as they could not associate their weaving with this phrase. Neither their representation, *naksha*, is called *talim*, nor it is read aloud like *talim* which could indicate outlines or background-weaving corresponding to their weaving activity and thereby anchoring that phrase in their experience. The phrase *doing talim* is a relic that ACW has retained from its historical Kashmiri roots. Something which is there, but hardly anyone knows why. The artifact (*talim*), which gave rise to this phrase, is long lost, but its linguistic appropriation has lingered.

This is what happens when a new artifact replaces another artifact in a practice under duress in a short timespan: it replaces the older artifact only superficially, as the arrival of the new artifact does not automatically bring new patterns of engagement as these patterns develop gradually over years or decades. Consequently, engagement patterns of old artifacts remain, but are disassociated from the new artifact. The resulting patterns that emerge have utility, but no meaning for the actors. This is why ACW presents an interesting case: it has a new artifact (*naksha*) but with shallow historical roots, while appropriation of an old artifact (*talim*) still remains, simultaneously. Even seventy years after India's Partition, ACW still seems to be in transition trying to adjust to both bygone and new eras insofar as its artifacts are concerned.

Findings 3: Social impact of new artifact *naksha* on practice

Artifacts shape the activity they are part of (Bodker and Klokmose 2011; Bodker et al 2016) impacting the cognitive profiles of their users (Hutchins 1995; Kirsh 2010; Norman 1991), other artifacts in their ecology (Callon 2004; Ueno et al 2017) and the resultant social structure of the practice and thereby, evolve in the process. Along with this evolvement, they alter the roles and relationships of actors. Besides significantly impacting the weavers' cognitive profile and their tasks, *naksha* has cast a deep social impact on ACW. Besides reducing ACW's task structure from three (designer, *talim*-writer, and weaver) to two actors (designer and weaver), this impact is most visible in the design complexity and creativity of ACW. Weaving of complex designs and the technology required to retrieve and execute design information are tied to each other. Together they impact the weavers' economic condition via their wage-rate, especially if they are working for a piece-rate wage (Roman 2016) as would be found in ACW. Due to complex information retrieval from *naksha*, ACW weavers showed less enthusiasm for complex patterns that would require relinquishing their established memory-based information retrieval. This is because reading complex patterns from *naksha* would require employing rigorous retrieval strategies and thereby require investing extra cognitive effort. Currently, ACW weavers are hugely underpaid: a regular carpet of 4x6 feet, taking a month to weave, fetches them merely 3500 INR. The extra cognitive effort required to weave complex patterns would not get them more wages. Hence, it makes sense to them to continue weaving simple patterns which they remember so well instead of weaving complex patterns at the same wage. Ideally, complex curvilinear patterns can be woven from *naksha* as is evident in Persian carpets (Topalbekirog et al. 2005), but in ACW, only if weavers are sufficiently paid. Low wages have consistently been rated as one of the primary challenges faced by weavers across the Indian carpet industry (Das et al. 2018; Majeed and Swalehin 2020) and ACW is no exception (Bawa and Joseph, 2010; Gill 2017). Without sufficient wages, weavers prefer weaving memorized patterns, and manufacturers, in order not to invest extra money, order the same pattern over and over again.

This weaving of the same pattern due to low wages and rigorous information extraction from *naksha* and vice versa is a vicious circle in which ACW was found engulfed. This has led to a very unique situation, perhaps unheard of in any practice so far: on 98% looms in the twenty-one villages visited by this researcher, *only one, single pattern, parda,* was found being woven. Figure 8 shows looms from three different villages weaving the same pattern with the only difference being that of colour and size. The remaining 2% showed other repetitive boxed-patterns like *mohri dabbi*. The weaving of a single pattern in the entire region has led to massive creative inertia in ACW where no new designs have come forth for many decades. A weaver, aW11 (M, 43y), revealed that he had been weaving *parda* for the last twenty-one years! The *karkhana*, where fieldwork was done for an extended period, had been weaving the *parda* pattern in different colours on all of its five functional looms. In one exception, a small *karkhana* of two looms was found weaving abstract

Figure 8a (Left), 8b (Middle), 8c (Right) Looms from three villages.

patterns whose digital designs were sourced by the owner from another weaving-city, Gwalior.

It may be thought at this juncture that digital creation of designs may alter this situation. Community interaction, however, has identified economic factors primarily directing the current design scenario. Hence, even if digitality is introduced in ACW, the situation is likely to remain the same: *the design representation, naksha, itself, whether manually or digitally created, does not allow easy information extraction* and *weavers are not willing to* spend extra cognitive effort on the same wages. Digitality is likely to ease the *designer's* work and change *their* situation, not the weaver's. Yet, the benefits of digitality cannot be undermined, e.g. in KCW, 90% of designing is done digitally (Kaur 2017) keeping manual setting to a minimum and where economic factors have hardly a say on design creativity *from the perspective of the weaver's ability* to weave the design. The weaver reads the *talim* and expends the same cognitive effort in its reading whether the encoded design is old or new, repetitive, running, simple, complex, or even three-dimensional. Even

after years of weaving the same design, no one can memorize it given the complex nature of even simple repetitions. More importantly, there's no *need* to memorize the design when the required information can be extracted from *talim* at any time. If "the world is its own best model" as Brooks says (1995, 54), why build another representation in the mind, like the weaver's memorized design, as seen in ACW?

Discussion

ACW presents a rare opportunity for studying the artifact-task-practice-cognition matrix where one artifact (*naksha*) completely replaced another artifact (*talim*) in a few years, pushing it out of its artifact ecology, and casting a longstanding socio-cognitive impact on tasks, users, and the practice. In cognitive science, artifact analysis of craft practices is a poorly studied domain (Kaur 2018) and even less studied is the historical analysis of artifacts generally. Historical analysis of an artifact's evolution and

appropriation over time can show the foundations of current user-artifact engagement patterns in a practice and the possible future trajectories of this nexus. Besides helping designers of those artifacts identify relevant points of observation in practical design (Kuutti 2011, 4), the prediction of future trajectories may enable policy-makers to make better policies regarding artisans working with their particular tools and remove glitches in those relationships like difficult information retrieval from *naksha* vs an easier one from *talim*, thereby improving the production process. Such policies are especially crucial in the context of Indian carpet industry which is facing huge challenges (Malik and Prasad 2015). Technological advancement is one of the solutions recommended to remedy the challenges faced by the carpet industry (Jahan and Mohan 2015; Gayatri et al 2022). The impact of user-artifact analysis range from financial to socio-cognitive and go a long way to improving the artisan experience. A straight line of action could be working upon the technology-design-wage matrix. In textile crafts, executing complex designs usually requires sophisticated representational technologies for easy retrieval and execution that then involves higher wages for weavers to compensate for the high cognitive and physical labour involved in operating such technologies, e.g. higher wages involved in operating jacquards to weave complex designs (Ramon 2016; Ramon 1992). Improving one knot of this link, i.e. the technology (*naksha* to *talim*), may ease the pressure of other units of this matrix. Weaving complex designs may not require higher wages if representational technology is good enough. Consider KCW where weaving of a complex curvilinear or simple boxed-

pattern fetches the same wages for the weaver. As artifacts exist in their ever-evolving artifact ecologies, introduction or removal of any artifact has a corresponding impact on its users, tasks, and practice. When an artifact gets replaced with another artifact in that ecology, the users' task, defined by that previous artifact, is changed, and with it changes the goals and preferences of the user. This leads to altered patterns of engagement. Centuries ago, when Persian carpet weaving was introduced in Kashmir in the 16th century (Gervis 1954; Saraf 1987), *talim*, a Kashmiri innovation (Harris 2001) was already being used in Kashmiri shawl-weaving (Harris 2001; Sajnani 2001). From the shawl-artifact ecology, *talim* was introduced to carpet-ecology, altering the imported carpet-artifact ecology from Persia forever, which still uses the *naksha*, called *cartoons* in Persia/Iran (Topalbekirog et al. 2005, 540). When, and under what conditions, *talim* replaced *naksha* in KCW is unknown. Besides shawl-weaving, *pile* carpet-weaving spread to Amritsar around 1840 via migrating Kashmiri artisans (Hawley 1913, 255; Chattopadhyay 1970, 23). These artisans had brought their designs, techniques, and materials of KCW with them (Armstrong 2022, 32) and after the Partition of India in 1947, *talim* was replaced by *naksha* because Amritsar was dismantling its hitherto established ecology inherited from Kashmir. This altered its actors' tasks and practice forever. With *talim*, the weaver's task was to *read* the design information, with *naksha*, this was changed to *figuring out* the design information. The altered task involved a series of operations like identification of row, column, and cells, and the calculation of cells falling under a particular colour, thereby increasing the weaver's cognitive

load. When *talim* disappeared from ACW, ways of engaging disappeared with it, e.g. information retrieval, but some appropriation remained, some linguistic relics like *doing talim*, a phrase that weavers still use without knowing why.

Socially, the artifact replacement had a dire impact on the structure of ACW as it led to the vanishing of an actor from the practice after the Partition of India in 1947: the *talim*-writer. This shifted the goals and responsibilities of *talim*-writers onto the designer, diminishing the *talim*-writer's need further and leading to his eventual extinction from the practice. This altered the practice's structure from (designer → *talim*-writer → weaver) to (designer → weaver), giving rise to new roles, relationships, and sets of goals that competed with each other. Beside addressing creative issues, the designer, post-Partition, needed to ensure accurate communication and execution of design information. The new set of goals, i.e. executability or creativity, competed with each other under constraints posed by market forces and the weaver's cognitive load. One factor won out in the end: executability! One could bear the repetition, but failures in execution that stall activity were detrimental. Thus, one could afford to get one design made again and again, but not in the situation where design information was not retrievable at all. The result: the same design being woven over and over and over, but a correctly woven design! Creative inertia, but correct weaving!

Thus, poor engagement patterns with the new artifact, *naksha*, hampered the design creativity of the industry in the long run. The ability to weave complex designs have mutually evolved with technological advances in handloom weaving (Roman 2016). As the "home of carpet weaving" (Mumford 1900, 259) pre-1947 Amritsar was considered the "most important carpet weaving centre" of India (Watt & Brown 1903, 430), known for wool and even "pashmina" carpets (Watt & Brown 1903, 261). Producing the "finest of modern Indian rugs" (Holt 1901, 65) exported chiefly to America (Twigg 1907, 82), its designs and methods were followed by art schools across the country (Twigg 1907, 8). The designs of pre-Partition Amritsar carpets strongly resembled their Kashmiri counterparts (Colonial and Indian Exhibition 1886, 255), which involved "shawl pattern" motifs with "dark coloring" and light texture (Gazetteer of Amritsar 1883, 45). These were characterized by Kashmiri floral patterns, and at times, "large, simplified motifs with dense pile" (Armstrong 2021, 34). From 1880 onwards, ACW introduced "innovations in design, palette, and materials" and together with its unique business model transformed itself into a flourishing export industry (Armstrong 2021, 34). The situation, however, deteriorated after Partition with ACW registering a decline in design diversity, knottage, and number of colours over the years. Amritsar carpet weavers wove around 400 kpsi in 1920 (Playne 1920, 606) which declined to 200–400 kpsi in the 1980s (Hasan 1984, 15), to 120 kpsi in the 1970s (Eiland & Eiland 1973, 298), and to a bare 100 kpsi at present. Likewise, for colours: as complex patterns are generally woven with large number of colours, in ACW, only five to six colours are being woven nowadays. This corresponds with its design simplicity as compared to 10+ colours used in the pre-Partition era, showing a miserable decline of design diversity as

this brief catalogue of antique carpets in Figure 9 shows. ACW is a classic case of a riches-to-rags rug-story. Amritsar is a centre whose commerical productions and even prisons (Gazetteer of Amritsar 1883, 45; Baker 1915; Watt & Brown 1903, 426; McGowan 2008) produced the highest quality carpets, which were worth displaying in the Great Exhibitions of London in 1851 (Baker 1915, 252) and 1862 (Kipling quoted in Mukharji 1888, 393), in the Calcutta Exhibition of 1883 (Gazetteer of Amritsar 1883, 45), and the Delhi Exhibition of 1903 (Watt and Brown 1903, 430), but the centre now produces only one simple repetitive pattern which indicates a gloomy state of affairs.

This is the co-evolution of artifacts, tasks, actors, and practice that cultural-historical-activity theory (CHAT) and situated-distributed cognition (SIT-DCOG) argues for (Callon 2004; Lave 1988; Hutchins 1995; Kirsh 2010; Vasiliou et al. 2017). ACW contributes a curious case of *artifact replacement* to the landscape of artifact ecologies where one artifact (*naksha*) completely replaces the other (*talim*) in a short span of a few years, casting a longstanding socio-cognitive impact on users, tasks, and practice. An improvement, if any, that has occurred in ACW, over these years, has been in the loom structure, i.e. the use of a wooden strip (*panakh*) on the loom's backside which keeps the carpet stretched between both ends during weaving (figure 3b). When and how this very important innovation occurred, whether through "horizontal transfer" among adjacent weaving communities or invention (Buckley and Boudot 2017) is not known as it is found neither in Kashmiri nor in Persian carpet-weaving. This shows that despite being

adjacent to Amritsar, Kashmir remained aloof of this critical innovation where carpets often cave in from the sides, forcing manufacturers to do repairs before sale.

Recommendations

Market-wise, ACW fares a little better than KCW, yet, more aggressive efforts are required to salvage the declining practice (Bawa and Joseph, 2010; Gill 2017). Besides improving marketing and wage-infrastructure, its artifacts need to be reconfigured in order to make the artifact-task link more meaningful, robust, and cognitively economical for the actors, thereby improving their weaving experience. One option is to bring the *talim* back. This will not only ease weavers' cognitive load during design information retrieval, but also boost the design creativity of the industry and lift it out of the creative inertia in which it is immersed today. Besides that, it will revive the lost heritage of larger Punjabi culture. Another option is to encourage computer-aided design (CAD) intervention which may attract young designers producing a wider repertoire of design.

Summary

Amritsar carpet-weaving (ACW) presents a rare chance for studying the co-evolement of artifact-task-user-practice coupling and resultant socio-cognitive impact where one artifact completely replaces another artifact in a short span of time, pushing it out of its ecology altogether. Post India's Partition in 1947, the practice changed with *naksha* replacing the existing artifact *talim*, which it had inherited from its Kashmiri-roots. The resultant patterns of engagement with *naksha* cast significant cognitive impact

[Fig. Antique Amritsar Carpet, 1890
15'1" x 11'5", Farnaham Antique Carpets, UK]

[Fig. B Antique Amritsar "Garden Rug", 1875,
3' 10" x 5' 10", Claremont Rug Company, USA]

[Fig. C Antique Amritsar Carpet, late 19th Century,
7.9 x 9.2, Heirloom, USA]

[Fig. D. Amritsar Prayer Rug, 5.10 x 3.4,
Holt 1910: 64-65.]

Figure 9
Amritsar Pre-Partition Catalogue of Designs.

on weavers and their tasks causing difficult information retrieval and impacting design communication and coordination among their teams. Coupled with economic factors, this caused widespread resistance to novel and complex patterns, triggering a massive creative inertia, leading to a situation where only one pattern is currently being woven in the entire practice. This is not to say that complex patterns in Amritsar carpets will not be found in market at all. Such designs could be found, but most of these designs are either old stocks sold as antiques or are standalone efforts of a handful of manufacturers seeking intervention from other centres and hence, are *not* representative of ACW at large.

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Figure-9A: Available in 10 Year Anniversary Collection Brochure at: https://www.farnhamantiquecarpets.com/wp-content/uploads/media/34754-Farnham-Antique-Carpets-10th-Anniversary-Brochure-210x265mm-web-links.pdf?download, p. 15. Courtesy: Farnaham Antique Carpets, UK

Figure-9B: Available at https://www.claremontrug.com/antique-oriental-rugs-carpets/indian/neutral/amritsar-garden-rug-indian-antique-rug-6209/massive/ Courtesy: Claremont Rug Company, USA

Figure-9C: Available at https://www.heirloombk.com/products/antique-amritsar-rug-7-9-x-9-2 Courtesy: Heirloom, USA Nationsonline: https://www.nationsonline.org/gallery/India/India-Admin-Map-M.jpg. Accessed on 5 June, 2023.

PCMEA: https://pcmea.org.pk/about-pcmea/ Accessed on 12 December, 2021.

1 When designs are created digitally, the *talim* is generated by the CAD system itself. There is no difference between a manually generated or a digitally generate *talim*. Both *talims* are written on similar long rolls of paper. For further details, see Kaur 2017 b, 2021.

2 Regarding *talim*'s use in Amritsar carpet weaving, see also Langton (1904, 212); Journal of RSA (1914); Chattopadhyay (1976, 68); Gans-Ruedin (1989); Saraf (1990, 93); Bawa & Joseph (2010).

3 3500 converted to US dollars is roughly $50, while 1500 is $20 (as of June, 2023).

4 Graph/graph-sheets/*naksha* are usually used interchangeably in ACW and KCW. However, for the purposes of clarity in this paper, graph can be understood as any grid-based sheet, comprising rows and columns organized in blocks. When design is drawn over such graphs, it is called *naksha*.

5 There are 23 districts in the province of Punjab, one of which is Amritsar. The district has a city of the same name of Amritsar as well which is also the headquarter of this district. The district has 9 blocks one of which is Ajnala and 776 villages. The Ajnala block lies adjacent to the international border with Pakistan and has around 165 villages. Ajnala block is around 26 kms away from the city of Amritsar. The fieldwork was done in 21 villages of this block. The weaving is carried out mainly in this block and also in some villages near the city of Amritsar.