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The Craft System, Historical Development, and Knowledge Transmission of Gold and Silver Precision-Fitting -- A Craft Ethnography Based on Intangible Cultural Heritage Transmission Practices in Kunming

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Abstract

Gold and silver precision-fitting is a traditional handcraft within the broader field of fine metalworking. It uses precious metals and precision filing to achieve close, seamless fits between jewelry components. Drawing on published sources and records of hands-on practice, this study examines the craft's historical development and technical system, with particular attention to the principles and operating procedures of filing, its defining technique. It also distinguishes precision-fitting from conventional stone-setting and other forms of decorative inlay. Three findings emerge. First, unlike conventional setting techniques, which primarily serve a decorative function, gold and silver precision-fitting is based on a mode of making in which structural integration is the principal objective. Second, filing is the craft's central technique; its operating procedures and precision controls define the technical character of the practice. Third, documenting experiential knowledge and translating it into reproducible procedures are essential to the continued transmission of traditional craftsmanship. The craft's ideal of consistency between internal structure and external appearance also offers an ethical point of reference for reflecting on certain tendencies in contemporary consumer culture.

Keywords:

gold and silver precision-fitting; fine metalworking; filing; intangible cultural heritage transmission; embodied craft knowledge

1. Introduction

Within the genealogy of traditional Chinese gold- and silverware production, fine metalworking encompasses a broad range of specialized techniques. In Zhongguo xijin gongyi yu wenwu [Chinese Fine Metalworking Techniques and Cultural Relics], Yang Xiaolin identifies several branches of this technical system,

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including filigree, precision-fitting, chasing and engraving, soldering, gilding, cloisonné enameling, and gemstone setting (Yang, 2008, p. 51). Filigree and inlay are widely recognized for their intricate decoration. Precision-fitting, although similarly rooted in a long history, has received comparatively little scholarly attention.

Several factors may help explain this imbalance. First, precision-fitting was historically transmitted primarily within families and through master–apprentice instruction, with few systematic written records. Second, the expansion of industrial mass production has steadily reduced the market for hand-fitted objects, placing the continuity of the craft under pressure. Third, scholarship on fine metalworking has tended to emphasize visible features such as patterns and forms, while paying less attention to internal structural relationships and the bodily skills of artisans. Feng (1995) observed that precision-fitting techniques had emerged more than 3,000 years ago, during the Shang dynasty, and had become highly developed by the Tang dynasty, when many technically accomplished objects were produced; in his view, China's relative decline in this field occurred only in modern times. This assessment reflects a broad understanding of the craft's history within the trade.

The first author was trained in the gold and silver precision-fitting tradition of the Li family of Nanjing and is one of the principal contemporary inheritors of the practice. He is currently a representative inheritor of the Kunming Municipal Intangible Cultural Heritage project. The processes and technical standards described in this article are drawn from family instruction and the first author's records of practical work. Taking the transmission of gold and silver precision-fitting in Kunming as its subject, this study combines a review of the literature with records of practical experience to address three questions: What are the technical system and underlying logic of the craft? How should the operating procedures of its core technique, filing, be understood? And how can knowledge of this craft be transmitted in the contemporary context of intangible cultural heritage protection?

2. Defining "Precision-Fitting": Terminology and Technical Positioning

2.1. The emergence of "precision-fitting" as a trade term

In scholarship on traditional Chinese metalworking and fine gold- and silverware production, precision-fitting does not refer to a single decorative technique. Rather, it is a distinct technical category combining metal deformation, fine machining, and mechanical assembly. The term is a modern trade expression used in the gold- and silverware industry, particularly in the Beijing filigree and inlay sector (Zhang, 2024, p. 272). Contrasted with filigree, it refers to a production approach in which sheet and wire materials are shaped, filed, set with gemstones, and soldered into finished objects. The term does not appear in Tang- or Song-dynasty texts.

The traditional gold- and silverware industry reached an exceptionally high degree of specialization in the Qing imperial workshops. Production was divided into more than ten trades, including precision metalworking, setting, chasing, assembly, enameling, kingfisher-feather inlay, gold cladding, plating, wire drawing, and beadwork (Mei, 2016). Within this highly differentiated system, precision metalworking and assembly were established as two principal branches, each with a complete production process and independent finished products. The remaining trades generally supplied processed components or semi-finished parts. This positioning meant that precision-fitting did not depend on chemical adhesives. Instead, it relied on mechanical

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processing of metal in the cold-worked state, using filing, sawing, soldering, riveting, and other physical techniques to join individual components precisely.

2.2. Differences from conventional setting techniques

From the perspective of craft history, gold and silver precision-fitting is technically related to conventional setting, but the two differ substantially in their objectives, methods, and criteria of evaluation.

First, their objectives differ. Conventional setting is primarily intended to produce a decorative effect: the color, luster, and form of a gemstone or other ornamental element should be displayed to advantage while remaining securely fixed. Gold and silver precision-fitting, by contrast, places greater emphasis on structural integrity and function. It seeks consistency between the inner structure and the external appearance: the assembled object should look visually seamless while remaining structurally stable, durable, and fit for use.

Second, their technical methods differ. Conventional setting centers on embedding and securing a decorative object in a metal setting. In precision-fitting, filing is the principal operation, used to achieve accurate fits between components. Yang, Fan, and Wang (2007, pp. 312–315) describe precision-fitting as a form of production based primarily on filing, using sheet and wire materials of sufficient hardness for fabrication. The manufacture of claw-set gemstone cups provides an example of filing at work. In a dropped-claw cup, excess sheet metal is filed away from a rimmed setting. In a claw-set cup, metal claws of different shapes are soldered to a stone base; the claws grip the gemstone in place of a continuous rim. Claw settings may use two, three, four, six, or eight claws, arranged in cross-shaped or bench-like configurations and formed as triangular, oval, square, or pointed claws (Ministry of Labor and Social Security, 2003).

Third, the criteria of evaluation differ. Conventional setting is judged mainly by its decorative effect and the security of the setting. Precision-fitting is subject to more exacting standards: components must fit tightly, traces of assembly should be concealed as far as possible, and the finished object should appear to be an integral whole.

This distinction points to a fundamental difference in the logic of making. Conventional setting is primarily an additive decorative process: an ornamental element is incorporated into the surface of an already formed object. Precision-fitting is a form of structural fabrication: multiple accurately processed components are brought together to create a unified object.

3. Historical Development: From Early Technical Practices to the Formation of Court Workshops

3.1. Pre-Qin period to the Qin and Han dynasties: early technical practices

The precision metalworking on which gold and silver precision-fitting depends can be traced to techniques practiced before the Qin dynasty. The gold-and-silver inlay found on Shang and Zhou bronze vessels involved inserting gold or silver wire into the surface of bronze objects to form decorative patterns, displaying basic characteristics of metal inlay (Shi, 2022, p. 228). The process involved preparing or chiseling grooves in the bronze surface, manually hammering or pressing highly malleable gold or silver wire or thin sheet into them,

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and then polishing the surface flush. By the Eastern Han dynasty, this cold-pressing technique had reached a high level of precision. Objects excavated from the Mancheng Han tombs, including a gold-inlaid bronze boshan incense burner and a gilt-silver bronze vessel decorated with a coiling dragon, show exceptionally tight integration of gold and silver elements with the bronze surface (Wang, 2022, p. 34). The turquoise-inlaid bronze animal-mask plaque excavated at Erlitou further indicates that, during the Erlitou culture (approximately 1750–1520 BCE), craftspeople were already capable of finely grinding inlay pieces to achieve close fits (Pan, 2023, p. 102).

A distinction is necessary here. The principal casting method for Erlitou and Shang–Zhou bronzes was piece-mold casting: a clay model was made, dried, and fired; a mold was then formed from the model, and molten alloy was poured into the mold cavity. The earliest generally accepted evidence for the lost-wax (investment-casting) method in China dates to the late Spring and Autumn period, by which time the technique was already relatively sophisticated. No early, technically rudimentary lost-wax castings have been identified. It is therefore inappropriate to date the introduction of lost-wax casting to the Erlitou period.

Metalworking techniques continued to advance during the Qin and Han dynasties. The bronze chariots and horses excavated from the Mausoleum of the First Qin Emperor exhibit sophisticated component-level and overall assembly. Their manufacture involved casting, setting, filing, grinding, punching, and chiseling, as well as joining methods such as soldering, riveting, hinged connections, and pin fastening (Shaanxi Provincial Cultural Relics Bureau, 2020, p. 9). Although these techniques were used mainly for bronze objects, their underlying principle—achieving close fits between components through precise processing—is technically related to the logic of later gold and silver precision-fitting.

3.2. The Tang dynasty: institutionalization in court workshops and technical maturity

The Tang dynasty was an important period in which gold and silver craftsmanship came to be applied on a large scale and within an increasingly organized system. Production was broadly divided into official workshops and private or commercial workshops (Zhang, 2012, p. 90). Accounts of the court's gold- and silverware production in the early Tang refer to the functions of the Zhongshang Office within the Directorate for Imperial Manufactories (Shaofu Jian), as recorded in the Tang liudian. Some scholars have noted that neither the Tang liudian nor the Old Book of Tang's treatise on official institutions, compiled during the Later Jin, mentions a "Gold and Silver Workshop Office," raising questions about the functions attributed to that institution.

By the middle and late Tang, a dedicated Wensi Office had been established within the court to produce gold and silver objects for the emperor and the imperial household (Shang, 2005, p. 160). A considerable number of gold and silver objects excavated from the underground palace of Famen Temple bear workshop inscriptions, including "made by the Wensi Office in accordance with the Xiantong imperial decree" and "made by the Wensi Office in the tenth year of Xiantong." According to incomplete statistics, 121 Tang gold and silver objects or groups of objects were excavated from the underground palace, 21 of which bear inscriptions (Yang, 1997, p. 288). An inscription on a gilt-silver salt stand supported by three makara-shaped legs indicates that it was made by the Wensi Office in the ninth year of Xiantong (868 CE). The inscription on the rim of a solid-gold alms bowl made to welcome the Buddha's relics records that the Wensi Office was ordered

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to make the bowl on the third day of the fourteenth year of Xiantong (873 CE). These finds demonstrate that a court workshop for gold and silver production known as the Wensi Office existed at least by the late Tang. Before the excavation of the Famen Temple underground palace, scholars generally believed that the Wensi Office had originated in the Song dynasty; the inscribed objects establish the existence of an institution of that name in the late Tang.

Objects from the Hejiacun hoard and the Famen Temple underground palace show that Tang craftspeople had mastered casting, hammering, soldering, cutting, polishing, riveting, carving, and openwork. The silver spherical incense burner decorated with grapes and birds from Hejiacun measures 4.6 cm in external diameter. It consists of two hemispheres joined along the horizontal midline by a male-and-female rim. Inside the lower hemisphere is a double-layered, two-axis gimbal made of silver. This double-axis concentric-ring mechanism keeps the inner incense cup level regardless of how the outer sphere moves. It is a notable example of precise mechanical fitting and close assembly in Tang metalwork (Li & Sun, 2021, p. 30). Together, the Hejiacun hoard and the Famen Temple finds demonstrate the high technical level of Tang gold- and silverware production.

3.3. Song through Qing dynasties: changing aesthetic priorities and the reduced visibility of precision-fitting

During the Song and Yuan dynasties, the stylistic preferences of gold and silver objects changed. Raised-relief decoration became widely used for principal ornamental motifs and developed into shallow-, medium-, and high-relief forms. In the Ming dynasty, gold and silver jewelry moved away from the restrained elegance associated with Song design. Filigree and inlay, enameling, and kingfisher-feather decoration helped establish a new visual language for jewelry. The gold crown excavated from the Dingling tomb of the Ming dynasty, known as the winged crown, is 24 cm high and weighs 826 g. It was woven from 518 gold wires, each 0.2 mm in diameter, using a technique described as “weaving lantern-like openwork,” and 8,400 dragon-scale pieces were soldered onto the crown to form a design of two dragons playing with a pearl (Lü & Zhao, 2013, p. 69). The sophistication of its weaving and soldering demonstrates the high level of Ming craftsmanship.

The changes from the Song and Yuan periods onward should therefore be understood as a shift in aesthetic priorities, rather than a decline in technical ability. Gold and silver objects increasingly emphasized surface decoration, including layered construction, relief, filigree, and chasing. Techniques centered on filing and close-fitting assembly became less visible in utilitarian objects, but they did not disappear.

3.4. Contemporary transmission: from family-based instruction to intangible cultural heritage protection

The gold and silver fine-metalworking tradition of Nanjing is a representative example of the Jiangnan tradition of precision-fitting and chased decoration. In 2008, the craft of gold and silver fine-metalworking was included in the second batch of China’s National Intangible Cultural Heritage list (Nanjing Municipal Bureau of Culture et al., 2008, p. 256). Gold and silver precision-fitting, as an important branch of fine metalworking, has also received recognition in this context.

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is one of its principal contemporary inheritors. Building on the family tradition, he has continued the craft in Kunming through production, teaching, and public dissemination. This work has gradually transformed knowledge formerly transmitted mainly through oral instruction and demonstration into a body of explicit knowledge that can be documented, checked, and taught. The craft was included in the district-level representative project list of Kunming's intangible cultural heritage in 2014 and in the municipal-level list in 2024. The first author is a representative inheritor of the municipal-level project.

4. The Technical System: Principles and Sequence of Precision-Fitting

4.1. Thirteen core operations in the technical system

The complete workflow for gold and silver precision-fitting comprises 16 operations: receiving a commission, drawing, refining, preparing stock, dividing the work into components, marking out, cutting stock, preparing parts, initial precision marking, precision machining, assembly, secondary precision marking, precision engraving, coloring, grinding, and polishing. Not every object requires all 16 operations, and filing and engraving may recur at different stages. Grouping the workflow into 13 core operations (Table 1) provides a clearer account of the craft's technical system.

No.	Core operation	Corresponding stage	Description
1	Commission assessment	Receiving a commission	Discussing the client's requirements and determining the design direction.
2	Design drawing	Drawing	Translating a sketch into an accurate, full-scale (1:1) working drawing.
3	Metal refining	Refining	Melting, alloying, and purifying the material.
4	Stock forming	Preparing stock; dividing into components	Initial material processing, including forging and rolling.
5	Marking out	Marking out (repeated as needed)	A precision-control operation carried out throughout the making process.
6	Stock cutting	Cutting stock; preparing parts	Cutting and rough machining.
7	Filing	Precision machining; adjustment	The central technique, used at multiple stages.
8	Engraving	Precision engraving	Decorative engraving on the object's surface; optional.
9	Milling	Auxiliary machining	Optional use of powered tools for auxiliary processing.
10	Fitting and assembly	Assembly	Trial assembly and precision adjustment of all components before soldering.
11	Soldering	Soldering	Permanently joining components with solder.
12	Grinding	Grinding	Removing irregularities and leveling the surface after soldering.
13	Polishing	Polishing	Giving the object its final surface luster.

Note. Table prepared by the authors.

From a technical perspective, these 13 operations can be grouped into three levels:

(1) Essential operations: commission assessment, design drawing, metal refining, stock forming, marking out, stock cutting, filing, fitting and assembly, soldering, grinding, and polishing.

(2) Optional operations: engraving and milling.

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(3) Techniques used throughout the process: marking out and filing. Neither is confined to a single stage; both recur across multiple operations.

4.2. Filing: the technical logic of the core technique

Filing is the most important operation in gold and silver precision-fitting. Unlike many other metalworking practices, precision-fitting requires strict standards for file selection, grip, and movement. The close fit that defines the craft depends on disciplined filing.

In technical terms, filing removes minute amounts of metal through the teeth of a file. Each stroke removes very little material. The craftsperson controls the force and angle of the file so that the worked surface gradually approaches the intended dimensional boundary. Dividing material removal into smaller increments improves the reliability of the fit; this is the rationale for using filing, rather than more aggressive cutting, as the principal means of achieving precision.

The operating posture is also specific. The craftsperson stands with the feet turned outward at an angle of approximately 60 degrees and moves the upper arm in a straight line, with the waist serving as the center of motion. The wrist and elbow should not generate the movement independently. If the wrist substitutes for the waist, the file travels along an arc rather than a straight path, and a flat surface may become convex. Files are selected according to their cross-sectional profiles and tooth patterns: half-round files are used for concave curves, triangular files for internal angles, and flat files for planar surfaces. Coarse files remove material, while fine files refine and level the surface. Filing continues until the component reaches the marked layout line.

The difficulty of filing lies partly in its irreversibility: once too much material has been removed, it cannot be put back. The craftsperson must therefore continually judge the remaining machining allowance, measuring and comparing the work as filing proceeds. This requires spatial awareness, hand–eye coordination, and accumulated experience. The trade also uses specific inspection criteria. Filing stops when the scribed line disappears; the number of strokes on symmetrical parts is mentally tracked to keep both sides consistent; flatness is checked by holding a straightedge against the surface and observing transmitted light; and the fit between two components is examined by bringing them together and inspecting the gap. Although these criteria derive from workshop experience, they can be checked directly by another person, distinguishing them from judgments based solely on touch.

4.3. Fitting and assembly: precision matching and error control

Fitting and assembly is the precision-matching stage before soldering. Its purpose is to minimize discrepancies among components through trial assembly and fine adjustment. Fine files, including files wrapped in abrasive paper, are used to make minute corrections to mating surfaces. The machining allowance left during earlier stages is gradually removed. The components are repeatedly adjusted and test-fitted until they meet tightly, with no visible difference between the assembled parts and the appearance of the finished object. Only then is the assembly ready for soldering.

Three conditions indicate that the fit is satisfactory: the components come together naturally without being

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forced; once joined, they show neither visible gaps nor movement; and, even before solder is applied, the assembly already appears to be a complete object.

The difficulty lies in the interdependence of the fitting relationships. When several components serve as mutual reference points, adjusting one may affect the others. The craftsperson must repeatedly move between the overall structure and individual parts, making fine adjustments until all mating surfaces meet the required standard. An unwritten rule of the trade is that soldering should secure a form that has already been properly fitted; it should not be used to fill gaps left by inaccurate fitting. Filling gaps with solder produces visible color differences after grinding and is regarded in the trade as inferior workmanship.

4.4. Other core operations

Metal refining. In long-standing practice, precision-fitting has generally favored a silver alloy with a silver content of 95%, commonly referred to in the trade as "T950 silver." Under the Chinese national standard GB 11887, precious-metal fineness is indicated by the metal name, its chemical symbol (Ag), or the letter S followed by the parts-per-thousand fineness. The standardized designations for this material are therefore Ag950 or S950; "T950" is an informal trade expression rather than a standardized designation. During melting, a blowpipe is used to heat the silver until the molten metal rolls and flows together. Borax is added in stages as a flux to remove impurities and form slag. The appropriate temperature is judged from the flame color and the condition of the metal. When the molten silver changes from collapsing granules into a continuous flowing liquid and develops a smooth, mirror-like surface without wrinkles, it is ready to be poured.

Marking out. Marking out transfers reference lines and dimensional lines from the working drawing accurately onto the stock to be processed. A scriber is used rather than a pencil because the incised line remains visible during filing and can serve as a stopping reference. Marking out and drawing are complementary: the accuracy of every line affects the accuracy of the finished object.

Soldering. Borax solution is applied to the joints to help guide the solder. Soldering is performed in stages, beginning with solder of a higher melting point and proceeding to lower-melting-point solder, so that an earlier joint does not remelt during subsequent work. The entire object is first preheated with a reducing flame; a concentrated neutral flame is then used to solder the joint locally. Capillary action draws the molten solder into the gap. Oxidizing flames should be avoided when soldering silver because they may intensify internal oxidation of copper in the alloy and leave fire scale or discoloration that is difficult to remove by grinding.

Grinding and polishing. After soldering, a file is first used to remove borax residue trapped around the joints. The surface is then ground with progressively finer grades of abrasive paper. The direction of abrasion is changed by approximately 90 degrees with each grade; completion is judged by whether the scratches from the previous grade have been fully removed. Finally, a burnishing tool made of agate is used with a dilute detergent solution in a linear, parallel-stroke technique. The pressure induces plastic flow in the surface metal, producing a compact, burnished layer. The resulting luster is more subdued and durable than that produced by polishing with a buffing wheel.

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5. Embodied Craft Knowledge and Its Transmission

5.1. The tacit dimension of craft knowledge

Michael Polanyi's concept of tacit knowledge provides an important framework for understanding the distinctive epistemic character of traditional craftsmanship (Polanyi, 1966). He distinguishes between knowledge that can be expressed in words, diagrams, or mathematical formulas and knowledge that remains unarticulated and becomes apparent only through practice. This distinction aptly describes much of the knowledge found in traditional crafts: it is difficult to put into words and is transmitted primarily through bodily practice.

In gold and silver precision-fitting, control of filing pressure, choice of angle, and perception of rhythm all belong to this tacit dimension. Apprentices do not learn filing simply by reading a set of instructions. Through repeated observation, imitation, and hands-on practice, they gradually internalize the master's movements as bodily memory. The traditional expectation that an apprentice may need to spend three years watching before mastering the work reflects the limits of verbal instruction: what can be explained can be explained, but the remainder must be learned through the hands.

5.2. From "feel" to standards: pathways for making knowledge explicit

A central challenge in transmission is that tacit knowledge is difficult to pass on independently of bodily practice. When experienced craftspeople die, essential techniques may be lost. This does not mean, however, that such knowledge is entirely beyond documentation.

Contemporary efforts to transmit precision-fitting show that some experience-based knowledge can be converted into documented and reproducible procedures by analyzing working posture, breaking down marking-out operations into explicit steps, and recording filing practices. For example, the instruction to stand with the feet turned outward by approximately 60 degrees turns a verbal rule of thumb into a posture standard with a measurable reference. The instruction to file until the layout mark disappears replaces an intuitive judgment with a visible reference for precision control. Similarly, the vague instruction to "grind until the surface is ready" can be expressed as a verifiable condition: all scratches left by the previous abrasive grade must have been removed.

This conversion has limits. Subtle variations in pressure and timing cannot be fully encoded in words or symbols. Nevertheless, separating what can be documented and standardized from the tacit dimension makes it possible for apprentices to devote more attention to the core tactile judgments that genuinely require bodily experience. Making knowledge explicit does not replace craft practice with written instructions; rather, it reduces the time otherwise spent rediscovering procedures that can be clearly specified.

6. Conclusion

Gold and silver precision-fitting is a traditional metalworking craft within the broader system of fine metalworking. It is defined by precision filing and aims to achieve close, seamless fits between components. Its history extends from early technical practices in the pre-Qin period, through the institutional development of court workshops during the Tang dynasty, to contemporary efforts to protect and transmit intangible cultural

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heritage. Drawing on historical sources and records of practical work, this study has outlined the craft's historical development and technical system.

The analysis shows that precision-fitting differs from conventional setting, which is primarily decorative, in that it follows a logic of structural fabrication: multiple precisely processed components are fitted together to form a unified object. Filing, its central technique, is both a physical process of material removal and a practice of precision control achieved through coordinated bodily movement. Translating experience-based knowledge into documented, reproducible procedures is an important pathway for sustaining the living transmission of traditional craftsmanship.

The craft's commitment to consistency between inner structure and outward appearance, together with its insistence on close-fitting precision, constitutes not only a technical standard but also an ethic of making. In an era shaped by industrial production and consumer culture, this ethic offers a concrete point of reference for reflecting on certain tendencies in contemporary making and consumption. It also provides a case through which the value of traditional craftsmanship in contemporary society can be reconsidered.

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