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Marco Currò is the owner of MONI srl and M2Casting, companies operating in the gold industry in Valenza, making jewellery and microcast semi-finished pieces. Over the years, he has gained various work experience abroad, as a production consultant at the Indian and Chinese plants of an Asian group. He is currently working in planning and quality for the production processes of his companies.

*The traceability of production processes: from microcasting to the finished product.
Methods for monitoring precious metal working methods for the control of internal production flows and of the whole production chain as a whole.*

The proposed model aims to rationalise and map out the different stages in production, isolating any causes of error when identifying the title, origin and traceability of raw materials.

Traceability of production processes: from microcasting to the finished product

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INTRODUCTION

A workshop producing contract pieces or a company department where fine metals are transformed into alloys needs to be able to keep its production process under control or in other words, to apply the correct monitoring of material flows starting with the origin of the raw materials, can check the preparation of the alloy and the assembly stages for the semifinished pieces, then ends with inspection of the finished product ready for sale. A company able to follow material flows in this manner is definitely a company able to rationalise its in-house processes, isolate the causes of error and identify the origin of raw materials at any time, whether it is already transformed into alloy or still to be transformed. The application of this logic is essential when deciding to preserve the integrity of certified metals, to create a dedicated client warehouse or to guarantee the essential requirements for compliance with the reference standards regulating precious metals.

For example, consider the following standard requirements and bibliographic references:

U.S.A. Federal Law 21 July 2010 “Dodd-Frank Wall Street Reform and Consumer Protection Act”
National Regulation for Marks and Gold in Precious Metals, Legislative Decree no. 251 of 22 May 1999
Determination of gold in gold alloys ISO EN UNI 11426:2000
Quality Management Systems ISO EN UNI 9001:2008 Point 7.1 Product planning and implementation

These guidelines serve to show the effectiveness of a simple system which, if properly applied, will safeguard the whole production chain, both in the field of fine metals and also in the use of specific alloys chosen by the client.

ANALYSIS OF A GENERAL SYSTEM

We found that in a general production process, i.e. without a thorough system to monitor flows, the percentage of errors that can be traced back to human or process errors is significantly higher. The absence of a self-control method makes it impossible for the operator to guarantee the client any of the essential requirements of a product, i.e., the guarantee of a legal content determination and the reconstruction of the processes that transformed the raw materials into a finished item.

MODEL WITH TRACEABILITY SYSTEM

The model shown summarises the modes and some of the processes that are useful in guaranteeing the traceability and control of the metals used in microcasting processes.

The outline described is the standard flow we apply and normally repeat for any casting, as well as for the semifinished items needed for in-house production and also for processes destined to contracts.

We would like to point out that no processing waste, including items machined in our workshop, will return to the production cycle before it is first refined. We only use trimmings from the sprue cutting process made directly at the local microcasting unit and kept there (central or feed sprues) and in percentages that serve not to compromise the quality of successive microcasts.

The images below show the whole production cycle, divided as follows:

1. incoming raw materials
2. identification of metal alloy in the department
3. preparation of gold alloy
4. collection of sample to test gold content
5. preparation of microcast semifinished item kits

The incoming gold requires a careful visual inspection of punches: this is the marking of legal gold content, as punched in the gold

together with the mark of the assay office of origin.

Metals are not accepted if not punched and if necessary, client metal, received in punched blocks or certified ingots can be laminated in house in order to maintain the required weight and so that the plates, with illegible punch marks can only come from the newly laminated metal.

If required, it is also possible to manage a stock of raw materials dedicated exclusively to the client so that the complete traceability of client metal is guaranteed during the production process, i.e., dedicated microcasting where no other metal except that provided by the client is used.

The weights are prepared using a specially developed programme with the intent of minimizing error risks and making it possible to monitor the content of control shafts and the origin of the sprues/cuttings used.

Measurement instruments are all approved and regularly inspected with certified scales (class E2 and F1).

Every cast sheet has a sheet for checking its gold content.

Once the conformity of gold content has been decided for the cast, the database is completed to finish the records.

The top and bottom part of each sprue bears 2 plates, as shown in Figures 1, 2, and 3 and in both cases, the unequivocal casting process is given by the operator, by hand.



Figure 1 – Identification plates

We use the identification plates as a point of reference for testing; one is provided to the assay office and the other is left on the central sprue so as to guarantee easy recognition:



Figure 2 – Identification plates before collection



Figure 3 – 2nd identification plate for sprue recognition

To complete more accurate, stricter controls, samples of other cast metals, already tested, are collected for further analysis at a laboratory accredited by the Chamber of Commerce, Vicenza.

The main aim of this operation is to assess the ability to repeat the findings of the tests carried out at the assay office normally used and an accredited laboratory.

Table 1 is a real example of a comparison of data and the divergence found when comparing the two test reports.

GOLD CONTENT TEST						
Ref.	Assay office	Document		Tested gold content Assay office	Tested gold content SMP Chamber of Commerce (VI) (v.m.)	Divergence in thousands compared to content SMP Chamber of Commerce (VI)
		no.	date			
404 - 13		1021	18/10/2013	751,90	(v.m.)	-0,01
410 - 13		1037	23/10/2013	751,60	751,90	0,30
411 - 13		1038	24/10/2013	752,80	752,34	-0,46
117 - 14		253	12/03/2014	753,30	752,83	-0,47
200 - 14		253	12/03/2014	751,90	753,17	1,27
201 - 14		253	12/03/2014	753,40	753,57	0,17
202 - 14		253	12/03/2014	751,90	753,02	1,12
511 - 14		865	25/06/2014	752,40	752,11	-0,29
516 - 14		865	25/06/2014	752,50	750,66	-1,84
518 - 14		865	25/06/2014	753,10	752,04	-1,06
752 - 14		1434	14/10/2014	751,30	750,54	-0,76
756 - 14		1434	14/10/2014	753,00	752,52	-0,48
747 - 14		1426	13/10/2014	751,70	751,54	-0,16

Table 1 – Comparative table of data from assay office – SMP Chamber of Commerce, Vicenza

70% of castings are regularly tested; the remaining 30% are not subjected to checks as they are casts containing only the main feed sprues, the gold content of which has already been checked.

The cast sheet in fact highlights the origin of the sprues; for example, if a cast only uses sprue cuttings, there will be a field indicating the progressive cast processes from which the recycled alloy was taken.

The average gold content can then be found.

The following figures, 4, 5, 6 show a real example of the preparation of a cylinder weight, referring to the jobs contained, and the origin of the cuttings and the alloys used.

The example shows (circled in red), the internal jobs no. 637 - 638 and the progressive cast process no. 728; note the repeated information on the screen and in documents so as to be able to trace the production process from start to end.

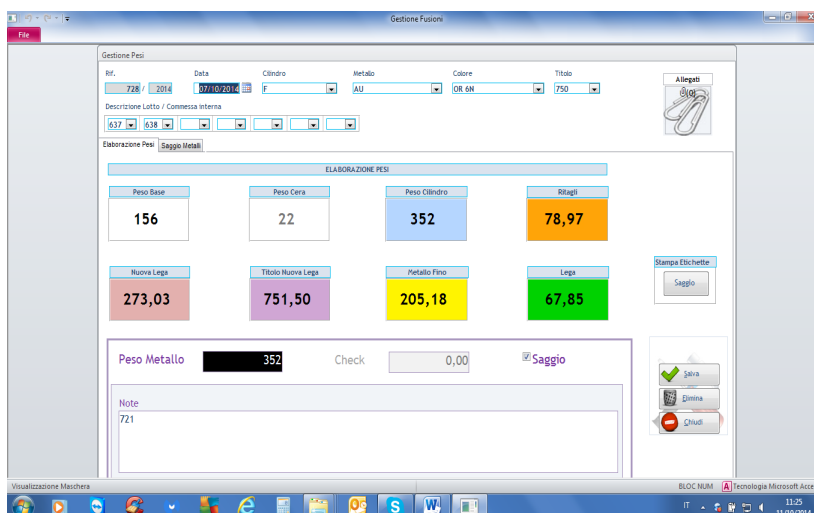


Figure 4 – Weight calculator

Ref.	Data Fusione	Cilindro	Metallo	Colore	Commesse interne	Peso Cilindro	Ritagli	Nuova Lega	Titolo	Oro Fino	Lega	Peso Metallo	Saggio	Note
723 - 2014	07/10/2014	A	AU	OR 6N	633	432	140,50	291,50	751,5	219,06	72,44	432	SI	719
724 - 2014	07/10/2014	B	AU	OR 6N	634	272	0,00	272,00	751,5	294,41	67,59	272	SI	
725 - 2014	07/10/2014	C	AU	OR 6N	634	352	131,30	220,70	751,5	165,86	54,84	352	SI	718
726 - 2014	07/10/2014	D	Ag	OR 6N	635	308	211,06	96,94	935	90,64	6,30	308	SI	659 683
727 - 2014	07/10/2014	E	AU	OR 6N	636-639	128	91,26	36,74	751,5	27,61	9,13	128	SI	709
728 - 2014	07/10/2014	F	AU	OR 6N	637-638	352	78,97	273,03	751,5	205,18	67,85	352	SI	721
729 - 2014	07/10/2014	G	AU	OR 6N	638	192	192,00	0,00	751,5	0,00	0,00	192		728

Figure 5 – Cast sheet

RIF.	Anno RIF.	Data	Cilindro	Metallo	Colore	Titolo	Saggio
729	2014	07/10/2014	G	AU	OR 6N	750	
728	2014	07/10/2014	F	AU	OR 6N	750	

Figure 6 – Material traceability per individual job

For the sake of coherent data comparison methods, all tests use the assay office at Valenza. Although it is not yet an accredited laboratory, it applies internal methods close to those envisaged by the UNI EN ISO 11426:2000 standard; for examples, if the standard procedure envisages a double refined, fine gold sample, their tests currently envisage only one. Every identification of gold content is achieved with at least 2 cupellation tests and 1 spectrometric test. The uncertainty of the average recognised by the assay office is approx. 0.50 thousandths for white gold and 0.25/0.30 thousandths for other alloys, a figure confirmed by further tests performed in Vicenza and listed in the table. The figure for the repeatability value complies with that stated in the technical standard of reference. The lowest value found in the tests is listed in the unloading document and entered in the system by us, as shown in Figure 7.

RIF.	Anno RIF.	Data	Banco Metall.	Num Doc.	Data Doc.	Titolo	Note
737	2014					752	
736	2014					752	
735	2014	08/10/2014	LINGOTTO	1409	10/10/2014	754	
734	2014	08/10/2014	LINGOTTO	1409	10/10/2014	751,1	
733	2014					752	
732	2014	08/10/2014	LINGOTTO	1409	10/10/2014	753,3	
731	2014	08/10/2014	LINGOTTO	1409	10/10/2014	751,6	
730	2014	08/10/2014	LINGOTTO	1409	10/10/2014	751,5	
729	2014					752	
728	2014	07/10/2014	LINGOTTO	1389	08/10/2014	752	
727	2014	07/10/2014	LINGOTTO	1389	08/10/2014	752,6	
726	2014	07/10/2014	LINGOTTO	1389	08/10/2014	942	
725	2014	07/10/2014	LINGOTTO	1389	08/10/2014	754,1	
724	2014	07/10/2014	LINGOTTO	1389	08/10/2014	751,1	
723	2014	07/10/2014	LINGOTTO	1389	08/10/2014	751,8	
722	2014					752	
721	2014	06/10/2014	LINGOTTO	1380	07/10/2014	752,2	
720	2014	06/10/2014	LINGOTTO	1380	07/10/2014	751	
719	2014	06/10/2014	LINGOTTO	1380	07/10/2014	754,8	
718	2014	06/10/2014	LINGOTTO	1380	07/10/2014	753,8	
717	2014	06/10/2014	LINGOTTO	1380	07/10/2014	752,1	
716	2014					752	
715	2014	02/10/2014	LINGOTTO	1377	06/10/2014	752,1	
714	2014	02/10/2014	LINGOTTO	1377	06/10/2014	753,1	
713	2014	02/10/2014	LINGOTTO	1377	06/10/2014	752	
712	2014	02/10/2014	LINGOTTO	1377	06/10/2014	752	
711	2014	02/10/2014	LINGOTTO	1377	06/10/2014	753,2	
710	2014					752	
709	2014					752	
708	2014	30/09/2014	LINGOTTO	1353	02/10/2014	752,9	
707	2014					752	
706	2014					752	
705	2014	30/09/2014	LINGOTTO	1353	02/10/2014	752	
704	2014	29/09/2014	LINGOTTO	1341	01/10/2014	752,8	
703	2014					752	
702	2014					752	

Figure 7 – Gold content testing data base

Once the tests have been received and the content checked, it is easy to guarantee the average gold content of each single micro-cast batch by associating the tables.

Figures 8 and 9 below provide an example of how orders are processed and kits reconstructed before entering into production or being delivered to the client.

On receipt of order, existing job/production order numbers are added with progressive internal numbering and once the microcast is completed, the kit reconstruction is traced and the material origin is entered.

Internal production order	Internal production order	Client	Description	Qty	Material origin (progressive cast process)	
2014	589		HEADS 001 AN	35	676	
2014	597		AN WITH HEADS	693	694	697
2014	618		N2202	703		
2014	631		N2202	13	721	
2014	638		AN WITH HEADS	729	728	
2014	643		AN WITH HEADS	26	735	
2014	646		AN WITH HEADS	740	741	
2014	650		N2202	746		

Figure 8 – Data base for reconstructing microcast kits



Figure 9 – Data base for reconstructing microcast kits

No batch can be reconstructed or delivered before the gold content is identified and there is a declaration stating the reconstruction of the whole flow, as shown in Figure 10.

Oggetto: dichiarazione conformità titoli

Con la presente si attesta che la merce risulta conforme alle normative vigenti in materia di titoli.

Di seguito un estratto del nostro sistema con le specifiche della composizione dei kit forniti e i risultati delle analisi. Si precisa inoltre che il metodo di determinazione del titolo applicato è vicino a quello previsto dalla norma

UNI EN ISO 11426:2000 , Il dato successivamente riportato dal banco metalli è il più basso delle due analisi effettuate.

ODP Interno	ODP Cliente	Cliente	Descrizione	Q.tà	Provenienza materiali(progressivi di fusione)														
2014 - 589		CLDQ	TESTE 001 AN	35	676														
2014 - 597		CLDQ	AN CON TESTE		693	694	697												
2014 - 618		CLDQ	N2202		703														
2014 - 631		CLDQ	N2202	13	721														
2014 - 638		CLDQ	AN CON TESTE		729	728													
2014 - 643		CLDQ	AN CON TESTE	26	735														
2014 - 646		CLDQ	AN CON TESTE		740	741													
2014 - 650		CLDQ	N2202		746														

SAGGIO METALLI

Rif.	BancoMetalli	Doc. N°	Data Doc.	Titolo Analitico
2014 - 676				752,00
2014 - 693	LINGOTTO	1306	26/09/2014	752,70
2014 - 694	LINGOTTO	1306	26/09/2014	753,10
2014 - 697				752,00
2014 - 703				752,00
2014 - 721	LINGOTTO	1380	07/10/2014	752,20
2014 - 728	LINGOTTO	1389	08/10/2014	752,00
2014 - 729				752,00
2014 - 735	LINGOTTO	1409	10/10/2014	754,00
2014 - 740				752,00
2014 - 741				752,00
2014 - 746				752,00

Valenza, 11/10/2014

M2Casting Via Baiardi, 8 15048 Valenza AL
Tel/Fax +39 0131 972230 Email: m2casting@monigioielli.com

Unità locale di: MONI srl

Viale della Rimembranza, 48 15040 Castelletto Monferrato AL Tel/Fax +39 0131 237836
P.IVA e C.F. 01885350064 R.I. AL - 2000 - 27589 R.E.A. 208460 ITALY

Figure 10 – Conformity declaration

The following, in figures 11 and 12 are the indications listed in the transport documents with details of the batches for which samples are being provided.



SPETT.

LINGOTTO Srl
 Strada Solero, 6/B
 15048, VALENZA (AL)
 P.I. 01278020068 C.F. 01278020068

Sede legale e operativa:
 MONI srl
 Viale della Rimembranza 48 15040 Castelletto Monferrato (AL)
 Tel / Fax +39 0131 237836 Capitale sociale € 18.000 l.v.
 P.I. / C.F. 01885350064 R.I. AL 2000 27589 R.E.A. 208460

Unità locale:
 MONI srl - M2Casting
 Via Baiardi 8 15048 Valenza (AL)
 Tel / Fax +39 0131 972230

LUOGO DI DESTINAZIONE

DOCUMENTO DI TRASPORTO



PAGINA	NUMERO	DATA	CAUSALE	
1 / 1	540 V	07/10/2014	C/LAVORAZIONE	
MEZZO DI SPEDIZIONE		TRASPORTO A CURA	TRASPORTO	VEETTORE
			DATA 07/10/2014 ORA 12:03	

DESCRIZIONE / NOTE	Q.TA'	U.M.	PREZZO	TOTALE
Campione per saggio RIF 723-14-A URGENTE	1,00	g		
Campione per saggio RIF 724-14-B	1,00	g		
Campione per saggio RIF 725-14-C	1,00	g		
Campione per saggio RIF 726-14-D AG	1,00	g		
Campione per saggio RIF 727-14-E	1,00	g		
Campione per saggio RIF 728-14-F	1,00	g		
RIEPILOGO				
Peso lordo 0,00 g	Totale Qt. 6			

Figure 11 – Transport document for assay office

Spett.
 MONI S.R.L.
 VIALE DELLA RIMEMBRANZA, 48
 15040 CASTELLETTO MONFERRATO (AL)

Luogo di Destinazione
 M2 Casting
 Via Baiardi,8
 1548 Valenza (AL)

DOCUMENTO DI TRASPORTO MERCI

Cod. cliente	P.Iva/Cod. Fiscale	Numero	Data	Pagina
C 684	01885350064	DCL/001389	08/10/2014	1
Causale del trasporto		Porto		
RESO C/LAVORAZIONE				

Codice Articolo	Descrizione materiale (natura e qualità)	UM	Quantità
	RIF. VS/ D.D.T. N. 540 V del 07/10/14		
	Campione rif. 723-14-A g 1,00 Au tit. 751,80		
	Campione rif. 724-14-B g 1,00 Au tit. 751,10		
	Campione rif. 725-14-C g 1,00 Au tit. 754,10		
	Campione rif. 726-14-D AG g 1,00 Ag tit. 942		
	Campione rif. 727-14-E g 1,00 Au tit. 752,60		
	Campione rif. 728-14-F g 1,00 Au tit. 752,00		
N	saggio	N	5,00
N	saggio	N	1,00

Figure 12 – Assay office document listing the samples tested

The following is a simplified example of a flow, summarizing the process:

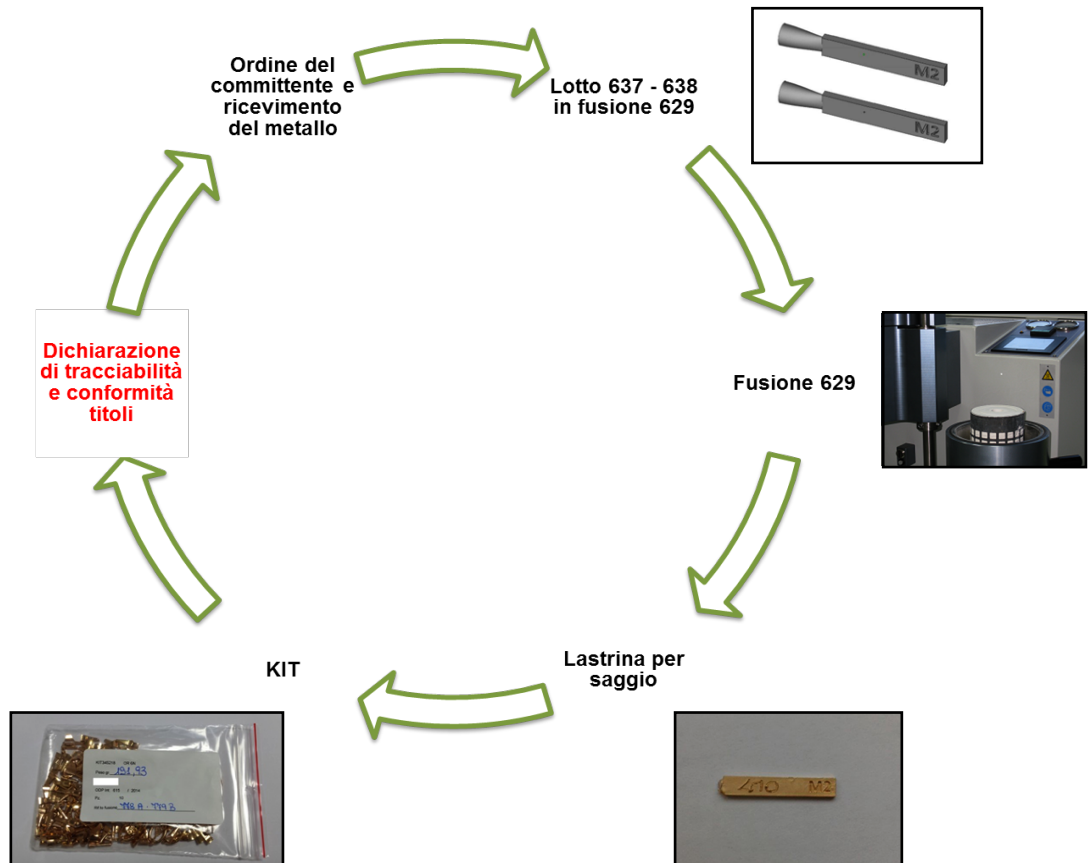


Figure 13 – Flow from incoming metal to the delivery of cast semifinished items

CONCLUSIONS

In conclusion, the traceability of the metal used in the production process may be guaranteed easily by applying simple, internal self-control logic. The proposed model has been found to be very effective for microcast processes and also guarantees the same result in contexts with significant amounts of metal to be worked.

Naturally, it can also be used in different processes (e.g. continuous casting), although it would need precise adaptation.

Although the working processes for jewellery are manifold and often not carried out in a single premises, it is essential to broaden the control method to cover every step in the process in order to guarantee the supply chain and not cancel out the attention that goes into the initial stages.

We should note, in fact, that monitoring approximately 1500 casts in 2 working years, only 3 non conformities have been found and isolated, due to operator distraction: two of these could be traced to the cast stage and one to the weight processing stage.

It is obvious that this method of control is more costly in terms of time and resources compared to a general system to guarantee effectiveness, but specifically, we should consider the following:

1. increased checks for every single microcast job
2. increased costs for testing and refining
3. smaller cylinders to reduce a mix of jobs within each
4. smaller cylinders for a single client stock (e.g., certified gold)
5. it is impossible, following points 3 and 4, to optimise space for melting in furnaces with the result of implementing systems or increasing product lead time.

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