OPTIMISING PRODUCTIVITY IN FOUNDRY

In a foundry, it may not be justified to analyze only obvious failures as reasons. Failures can happen in all processes like marketing, sales, production, quality, maintenance, product design etc. Efforts should be in optimizing outputs of all processes with a goal to synchronize them, improve and sustain overall plant utilization.

When the deal of supplying castings to a customer is concluded, obviously nobody plans a loss in business and instead a profit margin is built in. Still in practice we find it difficult to achieve it. Obviously we are not able to achieve the steps defined, results of quality, yield and run rate anticipated while concluding the business. We may have not run the product through our existing infrastructure, skill levels and defined what to achieve in each process and if it is possible to achieve in given facilities. If we call induction of product as invention, innovation later on is the scope for further improvements and perfection.

The exercise of optimization should start at product/project conceiving stage. Each process should have clear definition of capacity, capability, repeat reliability, online interaction and linkages with other processes and the parameters/activities which need to be achieved, tracked and monitored for optimization. This warrants domain competence in all process owners. The addition of new products in operating foundry should be tailored to suit existing set up or fine tune the set up to accommodate needs of new product as defined.

PAST LEGACIES:

Foundry is a complex process as a whole of many sub-processes dependent on each other. The concept of internal vendor and customer was missing. General tendency is to explain away the problem and analysis ends in fixing the blame rather than solution. The random failures make us slave as proactive approach of "PREDICT AND PREVENT " is missing. Good results are by luck in many cases if we are not able to repeat and sustain them. It needs synchronized team work in all processes complementary to a common goal. Off line and support activities like maintenance, purchase and quality are unaware of results of their inputs in main stream process.

SOURCES OF UNRELIABILITY: General observations of the total loss are:

A)Operations 30-50%: Poorly defined operating procedures, ineffective cross functional teams, lack of training, lack of measures and targets in each process as vendor to next process and customer of preceding process . We lack on line monitoring and controls/validation at each step/activity and instead wait for disaster to happen, inadequate skills and understanding of equipment in use. It is not understood that out put of one process is the input of other.

B) Assets 30-40%: Inaccurate initial specifications, inadequacy or again infrastructure to meet the defined requirements of run rate, quality etc, this results in introducing undefined changes.

C) Maintenance 10-30%: Inadequate knowledge of equipment and skills, inadequate on line monitoring of conditions and waiting for break downs instead, poor or no rebuild facilities, age of equipment and availability of spares and outside services.

NEW CHALLENGES:

We need to change our attitude from apathy to sympathy to empathy and achieve synchronized process approach and team work. Everybody in the organization must believe and demonstrate that they can do better, constantly challenge the status-quo and develop a constructive level of dissatisfaction with the present performance.

Chance or random causes are inherent sources present in the system for small day today variables and failures. They also cause output variability because they themselves are variables. Controlling them on line is the key.

It may be relevant to emphasize here that, the structure of process approach as defined by ISO/TS is best to follow, which says:

Management responsibility: Commitment, customer focus (I would profess internal customer and vendor concept which ultimately will reach external customer), planning, responsibility, authority and communication, review.

Resource Management: Human resource, Infrastructure and work environment.

Product Realization: Customer, design, purchase, operations, calibration.

Measurement, analysis and continuous improvement: Customer satisfaction, audit, process/product control, nonconformance, data analysis, improvements.

STANDARD REQUIREMENTS OF PROCESS APPROACH:

Each step in each process should have clear definition of repeat reliability, sequence and interaction with other processes, the measurable out put parameters with tolerances which need to be tracked, monitored and achieved with repeat accuracies, risk assessment in case of deviations etc. Ensure the availability of resources to carry out above.

Train all concerned to monitor, measure, analyze and implement corrective actions on line and track results. They can be trained in implementing on line checks with check lists which can be dynamic with risk mitigation plan.

Establish perfect communication mechanism in all shifts and all concerned of day’s observations, actions taken, tracking and monitoring effectiveness and feedback.

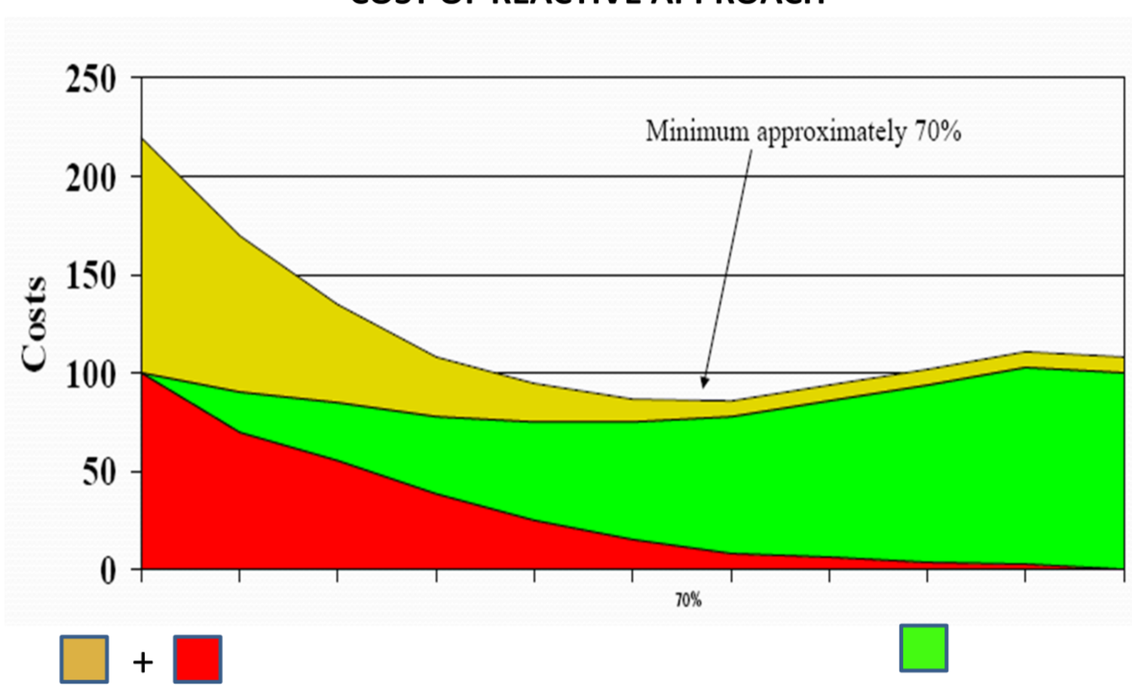
If the number of actions are ineffective, design out/ new definitions of process and facility is the only solution.

The above approach can be used for all processes. However, the achievement of parameters may be dependent on many activities in multiple processes. For example, a good mold is an output of, good mixing efficiency of sand mixer, correct discharge of sand in mold box, correct squeeze pressure and perfect alignment of machine to strip the mold. These conditions have to be ensured by Maintenance within tolerance. However, still the mold can be bad if pattern condition is bad, pattern mounting is not right, raw material quality is bad or pouring is delayed due to bad co-ordination between molding, core shop, melting etc.

One important point needs to be mentioned here is, when we go for a new project, it is easy to create infrastructure to meet defined requirements and skills, monitor deviations, on line correction etc. However, having created it or in existing facility, any new unplanned product needs to be passed through it before acceptance. What do we do in existing set ups? If creation of new set up is invention, fine tuning the existing set ups can be innovation. New instruments can be added, soft wares can be upgraded, slight layout modifications can be done for smooth and linear operations. Production process may stop due to bottle necking as castings are not moving to or out of fettling. Solution is to define life of the casting on floor, life of salvage castings on floor or improve plant capacity telescopically higher from melting to finishing.

This proactive and process monitoring approach with online corrections is the best for improving productivity. The graph below (taken from other source) is a good indication of direct and indirect benefits.

COST OF REACTIVE APPROACH



COST OF REACTIVE APPROACH **COST OF PROACTIVE APPROACH**

Objective – Optimize Operating cost. Cost of negligence is high.

There have to be Key attributes of effective process monitoring like:

1) Some redundant actions in Preventive Maintenance can be eliminated or schedules can be reduced. It may be observed that we overdo it and miss surprise mishaps.
2) The rejections, down time and costs of material, energy wastages have to come down gradually.
3) Training and communication to all people helps in nurturing culture of tracking/ monitoring and contribution of all team members. The data gets converted into information and then in value. The teams contributions become complimentary to common goal.
4) Improvement projects are identified correctly, cross validated and investment can be reduced.
5) Measurements can be created for each process like, number of calls per day for various issues like, breakdown, tooling, material loss of desired parameters and deviations.

HOW DO WE BEGIN ?

We are aware of major six losses in all processes. They are:

A) Down time: 1) Equipment failure 2) set up and adjustment

B) Speed losses: 3) Idling and minor stoppages -due to abnormal operation of line components and lack of co-ordination 4) Reduced speed -due to discrepancies between design and actual speed of equipment or deration in equipment.

C) Defect/Quality Losses: 5) Process defects -due to quality parameters going out of control 6) Reduced yield – critical design of product/ process/ tooling/methoding, unfit in given infrastructure.

Prepare the check list of all these parameters which can cause above losses. List can be one each for equipment, process and input and output of each process. The permitted tolerances and risk assessment should be part of daily check sheet or performance report. This can be discussed in daily work management meeting which can be on shop floor with team leaders of all processes. Decision can be communicated and feed back on monitoring actions and observations can be asked for. All formats can follow one principle of time balance. If we operate 24 hours and out put of the process is X, the theoretical capacity if the process/equipment operates trouble free for all 24 hours is known and the ratio of these two is our productivity. Rest all is to be treated as potential loss. Surprisingly we may find that for 60% output we have used 100% of the time. This 40% loss of time can be accounted for. This is difficult. However process wise sheets can be easy tool to monitor. For example, per hour melting rate of a furnace is known, if total liquid metal achieved is only 50% or equivalent to 12 hours of theoretical output of melting , the balance 12 hours is time/opportunity loss. This may include, melting equipment break downs, material and process delays etc, which will not add up to 12 hours. Without interfering in other processes, melting can make a statement that delays and break downs are 4 hours only and rest of the time metal was in holding due to non availability of molds to pour. Melting may never be able to achieve 100% performance, but should be able to assess potential to improve. May be melting and dispensation can be isolated, type of scrap can be changed for better packing densities etc to go from 70% to 90% utilization. Similar sheets can be made for molding, core shop and other processes, equipment wise and utilization can be monitored shift wise or day wise. Best is the operator carrying out activity should fill the format with his comments which can be consolidated at the end of the day. Only they can give factual data of delays.

Synchronizing and perfect balancing of all processes may be difficult. However we come to know which process is constraint and on account of what, like metal, molds, cores or product? Constraint should be exploited. Constraint needs to be identified in daily plan and target should be set. Best is to create adequate facilities in other processes which may not be investment intensive and create melting as a defined constraint. Liquid metal is the nascent production consuming material and energy costs over 50%. Irrespective of what process one owns, everybody should have a common goal of achieving day's liquid metal pouring.

One sample time balance sheet is shown for melting. It shows performance of melting process on daily basis. Some problems occur daily, some sparingly. However the frequency of a problem can be monitored and total time loss as well. This helps in deciding actions on the basis of severity of problem. At the end below, we can note actions with problem number indications date wise. This helps in monitoring the effectiveness of our actions. Monthly reports can be summarized for an year and on the click we can trace the history and actions of the problem, effectiveness of the problem and if required upgrading the check list for on line monitoring.

The format can be used not only for maintenance or equipment, but can be modified for tracking quality of components, specific or generic issues, cost and material consumptions etc. We can have a product wise data sheet and with number of items made in the month of each type, material consumption can be checked, what we should have consumed and what actually is consumed to achieve the production. The excess consumption may be due to bad quality, productivity or undesired changes adopted, but they were originally not planned as expenses and they are loss today. This provokes our thought process for improvement.

BENCH MARKING:

What we can not measure, can not be improved. Generally, this is a process of comparing our own performance with the best in Industry. Dimensions typically measured are Quality, Asset utilization, Time and Cost. Continuous improvements from self learning is the best method to adopt rather than global bench marking. No two foundries have same set up, skill levels and product portfolio. We can create our own performance tracking sheet on Time scale as above to measure our own performance and effectiveness of actions on day today basis.

Bench marking has to start from within and the bench marks within can be improved from month on month. These bench marks can be dynamic and process wise, like best achievements of one month can be bench mark for next. The average of the month is not to be reckoned for bench mark. Best 5 days performance in a month can be internal benchmark for next month.

This has a great relevance as the achievement was in given infrastructure, product mix, skill levels and complete data of the performance, etc. We need not do Failure mode and effect analysis (FMEA) only and always, we can as well do success mode and effect analysis (SMEA) of these 5 days. They help us to go to perfection in given set up gradually.

Sample time balance sheets for concept:

TIME BALANCE SHEET OF MELTING –MONTH 1

	Date	1	2	3	4	7	8	9	10	11	14	15	16	17	18	21	22	23	24	25	26	28	29	30	Total	Frequency
	Production time in Minutes	660	630	660	660	960	720	720	780	720	420	900	480	660	660	720	840	780	780	780	540	540	600	840	16050	
	Target LMT 6MW Power	132	63	66	66	192	144	144	156	144	84	180	96	132	132	144	168	156	156	156	108	108	120	168	3210	
	Actual LMT achieved	32.1	16.5	25.0	19.3	47.5	34.8	44.4	42.3	37.2	19.3	54.4	24.7	36.6	39.3	42.7	54.7	48.1	46.8	49.2	36.0	32.3	38.1	42.3	863.6	
	Utilization %	24.3	26.2	37.9	29.3	24.7	24.2	30.8	27.1	25.8	23.0	30.2	25.7	27.7	29.8	29.7	32.5	30.8	30.0	31.5	33.4	29.9	31.8	25.2	26.9	
	Time Lost in minutes	500	465	410	467	723	546	498	568	534	324	628	357	477	463	506	567	540	546	534	360	379	409	628	11428	
	KWH/ T of Liquid metal - Melting																								707	
	KWH/ T of Liquid metal - Auxiliary																								354	
A	**Maintenance Delays**																									
1	Furance trip ON GLD, metal piece	60	1 F off	1 F off	1 F off																				60	1
2	Furnace water low pressure / high temparature trip																								0	0
3	vibro charger problem																								0	0
4	Magnet Crane - CT Problem																								0	0
5	Furance charger supply incomer trip																								0	0
6	8T magnet Hot															40									40	1
7	POURING stopper rod sensor not sensing							31																	31	1
8	Furnace cylinder mounting welding break								60																60	1
	Subtotal Maintenance Delays	**60**	**0**	**0**	**0**	**0**	**0**	**31**	**60**	**0**	**0**	**0**	**0**	**0**	**0**	**40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**191**	
B	**PROCESS DELAY**																								**0**	
1	Metal Delay, capapcity constraint	224	193	164	207	373	170	145	212	170	131	290	142	172	214	186	290	230	251	295	158	152	193	275	4837	
2	Metal dispensation	95	58	89	69	170	130	150	151	132	68	194	88	130	140	152	195	171	167	175	128	115	136	151	3054	
3	Low temp. metal back																							33	33	1
4	Laddle suspension jam																								0	0
5	Metal Delay due Metal leak/GLD																								0	0
6	Pouring line stop/Metal Holding	34	9	20	29	49	41	60	45	32	25	52	25	55	68	43	50	61	45	30	33	35	30	123	994	23
7	Metal return due to metal spillage on box																								0	0
8	F/C problem metal shifting to furnace B																								0	0
9	Furnace Hood Jam																					30			30	1
10	Furnace A trip Srap piece onWCL pipe connection																								0	0
11	Furance Problem metal spillage F/C A.																								0	0
12	Metal composition delay																								0	0
13	furance jam																								0	0
14	furance holding	47	113	87	111	110	160		50	80	55	35	70	90		45		25	23	4		27	30	27	1189	19
15	Pouring nozzle Jam							62																	62	1
	Subtotal Process delays	400	373	360	416	702	501	417	458	414	279	571	325	447	422	426	535	487	486	504	319	359	389	609	10199	
C	**Other Dealys**																									
	Lunch	40	40	50	50	20	45	50	50	40	45	55	30	30	40	40	30	50	60	30	40	20	20	20	895	23
	Production Plan delayed		52							81															133	2
	Subtotal Other delays	40	92	50	50	20	45	50	50	121	45	55	30	30	40	40	30	50	60	30	40	20	20	20	1028	
	GRAND TOTAL DELAYS	500	465	410	466	722	546	498	568	535	324	626	355	477	462	506	565	537	546	534	359	379	409	629	11418	
	ACTIONS																									
A7	Sensor mounting Rod straightned							√																		
B15	Removed slag, cause of Jam								√																	
A9	Rewlded the cylinder bracket								√																	

Melting Summary- contd

S.NO.	MONTH	1	2	3	4	5	6	7	8	9	10	11	12	Year
	Production time	16050	16454	8876										
	Target LMT at rated Power	3210	3291	1775										
	Actual LMT achieved	864	847	645										
	Utilization %	26.9	25.7	36.33										
	Time Lost in minutes	11428	12219	5982										
	KWH/ T of Liquid metal - Melting	707	723	680										
	KWH/ T of Liquid metal - Auxiliary	354	358	263										
A	Maintenance Delays													
1	Furance trip ON GLD, metal piece	60	0	0										
2	vibro charger problem	0	40	0										
3	8T magnet hot	40	25	95										
4	SERT stopper rod sensor not sensing	31	10	0										
5	Furnace cylinder mounting welding break	60	60	0										
	Subtotal Maintenance Delays	191	135	95										
B	PROCESS DELAY													
1	Metal Delay, capapcity constraint	4837	5094	2174										
2	Metal dispensation	3054	2325	1779										
3	Low temp. metal back	33	279	0										
4	Laddle suspension jam	0	0	66										
5	Pouring line stop/metal holding	994	1763	0										
6	Metal return due to metal spillage on box	0	36	10										
7	F/C problem metal shifting to furnace B	0	0	51										
8	Furnace Hood Jam	30	0	0										
9	Furnace A trip Srap piece onWCL	0	6	0										
10	Furance Problem metal spillage F/C A.	0	100	0										
11	Metal composition delay	0	0	25										
12	furance holding	1189	890	1159										
13	Pouring stopper rod /nozzle Jam	62	280	135										
14	Pouring basin checking			0										
15	Sintering delay			60										
	Subtotal Process delays	10199	10741	5319										

Melting Summary- contd

S.NO.	MONTH	1	2	3	5	6	7	8	9	10	11	12	Year
C	**Other Dealys**												
16	Lunch	895	885	95									
17	Production Plan delayed	133	12	0									
18	Plasma trials		225	0									
	Subtotal Other delays	1028	1122	95									
	GRAND TOTAL DELAYS	11418	11998	5501									
	ACTIONS												
A4	Sensor mounting Rod bent, straightned	√											
B13	Removed slag, cause of Jam	√											
A5	Rewelded the cylinder bracket	√											
A2	Cleaned the metal on Track		√										
A3	1) Forward limit switch setting adjusted . 2) New braket fabricated & welding done		√										

CONCLUSIONS:

1) To improve on productivity, we must know and track failures and their severity, analyze and validate effectiveness of actions. Time balance sheet helps in doing it.
2) There is no subjectivity as all controls are in our hands and time is the only parameter we have no control. Time lost is lost for ever.
3) Daily works management standing meeting helps team work and distributes accountability and is a tool for fast communication.
4) It provokes thought process to identify and resolve unseen problems.
5) The issues are jointly discussed with all people involved and CFT approach gives fool proof solutions without side effects in inter process relations..

BY:

LAXMAN SUNDAR

(Foundry Advisor)

MAIL: lysundar@gmail.com