Utilizing Soft System Methodology to Increase Productivity of Shell Fabrication

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Abstract— The improvement in the productivity is a very challenging task. To improve productivity, it is important that the full involvement of the personnel. The productivity is simply defined as the ratio of rate of output to the unit rate of input. Productivity depends on factors such as process, quality, labour & production. To increase or improve the productivity we must improve the factors affecting it. In this paper, the productivity is improved by solving the problem related to process. In this problem is understood through the soft system methodology (SSM). In that the all personnel are involved to solve the problem related to processes in the shell fabrication shop (SFS) & reached to the proper solution which is elaborated in this paper.This project utilizes Soft System Methodology to determine the probable cause and the solution for the productivity issue in the fabrication shop. The technique involves removal of the Non Value Added Activities in order to bring about a reduction in setup time. This leads to reduced redundancy of activities in process.

Keywords: Soft system Methodology (SSM), Shell Fabrication Shop (SFS)

I. INTRODUCTION

Soft Systems Methodology (SSM) has brought about paradigm shift in solving mess created in fault ridden system engineering projects. With today's increasingly changing and dynamic product and services environment; innovation in processes and products is a necessary requirement. While the literature on innovation management is filled with studies from both organizational and inter-organizational perspectives, few studies have looked at supporting tools, methodologies, and infrastructure for innovation. The advantages of this approach are even greater when innovations and research and development projects are to be completed through inter-firm or inter-organizational efforts. In this paper, we present an example where alliances of organizations that are part of an industrial consortium have worked within SSM framework. The paper begins with a brief discussion on innovation management, focusing on characteristics of innovation management. A final summary and discussion provide avenues for future research and advancement of these and related techniques.

A. Background of Soft System Methodology

SSM was first introduced by Peter Checkland in 1981 in his book entitled "Systems Thinking, Systems Practice" (Checkland, 1981). SSM has been grouped among the "soft" operations research tools as opposed to the "hard" mathematical and decision models that have traditionally existed in the operations research field. It is a methodology for analyzing and modeling hard to define and complex systems that integrate both technology (or hard) system and a human (soft) system. The latter system is defined by Checkland as a Human Activity System (HAS) and is posited to be different from natural systems or designed systems due to the introduction of the subjectivity of human desires and objectives into the HAS. The HAS is defined as a collection of activities in which people are purposefully engaged, and the relationships between these activities. Checkland proposed that the same methods used for engineering technology may not work as well for the more unpredictable and complex human side of the system.

II. SOFT SYSTEM METHODOLOGY

SSM is a methodology used to support and to structure thinking about, and intervention in, complex organizational problems. SSM is a process for managing: for undertaking the process of achieving organized action. SSM practitioners take managing to be the process of thinking-out and implementing organized action, and of reacting to changes in the world which might affect that action.

SSM does take the process of management to be the sole preserve of a class of workers called 'managers'. Managing, in these terms, is an activity performed by all sorts of individuals, at all sorts of levels, in all sorts of formal and informal organizational groups. SSM assumes that each individual will see the world differently. Different world-views inevitably lead to varying understandings and evaluations of any situation, which lead in turn to different ideas for positive action. These ideas are not necessarily opposed to each other (there is generally likely to be some overlap), but they may be different enough to make the difference a serious issue when deciding on a course of action. SSM was developed out of systems thinking; when traditional systems thought process was found to be an inappropriate set of tools for dealing with problems in which there was no clearly defined and commonly agreed set of outcomes. The methodology was developed to help to make a sense of the difficult problems which contained their own, internal contradictions. Many projects have faced setback as a direct result of their failing to take into account the various perspectives, motivations and vested interests which are at play within human organizations. SSM provides a structure which is engineered to deal with these difficulties. In SSM, the structure of an organized intervention is used to deal with the complexity of an organizational problem. Although SSM has a clear structure, it is for the practitioner to use it in a flexible and user-friendly way.

An SSM intervention involves

- Finding out about the situation;
- Thinking about systems which are, or might be, employed in the situation;
- Comparing the thinking to the systems which exist in the real world;
- Implementing action according to what has been learned.

The basic model of SSM is a seven-stage model, which is described stage-by stage as below.

The seven stages do not represent a single process which can be followed from start to finish, after which a 'right' answer will be obvious. These stages are a well orchestrated process: the process may have to be repeated many times before a reasonable accommodation or agreement may be reached. The seven stages are:

- Entering the problem situation.
- Expressing the problem situation.
- Formulating root definitions of relevant systems.
- Building Conceptual Models of Human Activity Systems.
- Comparing the models with the real world.
- Defining changes that are desirable and feasible.
- Taking action to improve the real world situation.

The whole process of SSM is a process of mutual learning: the practitioner learns about the organization; the members of the organization learn about the diversity of views about and within their organization, and about their colleagues. The most important site for this learning is in the comparison between conceptually derived models and the real world. When such a comparison is made, the learning gained usually means the model needs to be revised. At the same time, exposure to the model often changes the problem situation, or at least perceptions of what the problem consists of. Through this conversational process of thinking, discussing, accommodating and re-thinking, practical ways forward may eventually be found.

A. Stage 1 and 2

Finding out the problem situation and expressing it through a rich picture is the first stage in soft systems methodology. As with any type of diagram, more knowledge can be communicated visually. Delivering such timetable helps to satisfy the concerned people which in turn affect the quality of educational activities. Different research methods or quantitative and qualitative analysis can be performed in order to express the problem situation and to elicit results that would enable the production of the Rich Picture and the progression to third step of SSM.

B. Stage 3

The third stage is formulating root definitions. A root definition is a sentence that describes the ideal system: its purpose, who will be in it? Who is taking part in it? Who could be affected by it and who could affect it? The root definitions and conceptual models can be formulated by considering the elements of the mnemonic CATWOE. CATWOE elements are Customers, Actors, Transformation process, Weltanschauung, Owner, Environmental factors.

Relevant systems are named in terms of root definitions. A root definition is a sentence expressed in natural language, consisting of elements in accordance with the mnemonic CATWOE:

- Customers- Who are the victims or beneficiaries of transformation?
- Actors-Those who would perform transformation
- Transformation process -The conversion of input to output.
- Weltanschauung- The worldview which makes transformation meaningful in a context.
- Owners-Those who have the power to stop transformation.
- Environment constraints-Elements outside the system which it takes as given.

In the stream of cultural analysis, there are three main examinations of the problem situation:

- Intervention analysis, i.e., analysis and reflection upon of the application of SSM to the problem situation. "Rich pictures" (informal drawings) are developed.
- Social system analysis, focusing on roles, norms and values in a problem situation.
- Political system analysis, answering questions related to power distribution in the problem situation.

C. Stage 4

Building the conceptual model is the fourth step. The conceptual model is formed to identify the main purposeful activities through a set of logical actions implied by the root definition.

D. Stage 5

In this stage, models are compared with the real world. In our case, comparing the model with the real world situation resulted in some discussions among the concerned people and included the following questions: Does this happen in the real situation? How does it happen in the real world situation? Based on what criteria is it judged? Is it a concern in the real world situation? In this way, the discussions resulted in the consensus among the concerned people about the proposed model as well as the changes that can be implemented to improve the situation.

Stage 6

This stage involves identifying systematically desirable and culturally feasible changes to the real world system. The feasibility is concerned with the matter of whether or not the potential change we would make is worth pursuing. The Cultural feasibility is considered primarily significant in SSM, and culture is not assumed to be static. Based on the comparisons made in the former stages, the following changes can be considered in our case:

Stage 7

This stage involves putting the changes identified in stage 6 in to practice.

III. CASE STUDY

A. Implementation of SSM

1) Entering the problem situation.

The above operating Procedure contains many dependent and independent Non Value Added Activities (NVA).The NVA's are :

- Chip Back (Independent)
- Tacking (Dependent)
- Root Pass (Dependent)
- Internal Re welding (Dependent)

2) Expressing the problem situation.

As seen before 3 NVA's are dependent on one primary or principal NVA i.e. Chip back.

- Chip back is Essential so as to remove the root face which is made up of base material.
- It is essential to remove the root face as it may cause failure in the weld due to difference in grain structure.
- Also root face may give rise to defects in weldment.

3) Formulating root definitions of relevant systems.
   – Inefficient Process Sequence utilizing more time for completion.
   – In order to improvise the productivity the focus area is eliminating the NVA's from the total cycle time.

4) Building Conceptual Models.
   – After studying the process flow of shell fabrication it is concluded that "rerolling of shell" is biggest NVA consuming considerable cycle time.
   – So it is decided to find a new way of shell welding which will cause less distortion in shape resulting in reduction/elimination of rerolling process ultimately leading to reduce the cycle time and avoid the NVA's.
   – Considering the above background a new concept of single side(single V) welding was thought of which also included the tack free set up process.

a) Previous method of welding (Double V)

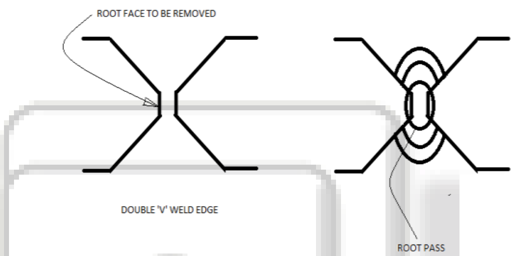

Fig. 1: Double V Method

Steps

After the rolling process the shell used to be kept in the rolling machine for tacking (i.e Setup) leading to continuous use of crane and idle rolling machine until the tacking is done (which includes pre heating & post heating) Ref fig. 2 and fig. 3.

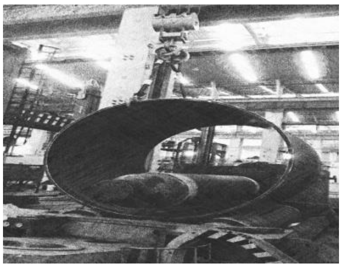

Fig. 2: Usage of Crane.

Fig. 3: Tacking

Then the shell is taken for outside welding.

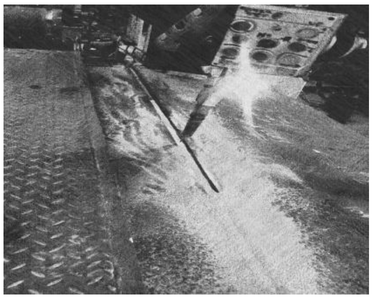

Fig. 4: Outside Welding

After completion of outside welding chip back grinding is done followed by die penetrating (P.T) test.

Fig 5. Chipbak Grinding

Chip back welding is further done.

Later the shell is taken for profile grinding and shape correction by rerolling the shell in rolling machine again

Fig. 6: Flush Grinding

b) New methods thought of for welding

(1) Use of ceramic plates for the single side weld

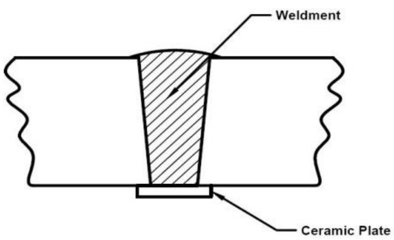

Fig. 7: Use of Ceramic Plates

Steps:

– After the rolling the shell is directly removed from the rolling machine avoiding the use of rolling machine and the crane.
– Ceramic stripes were used as shown in figure.

– But it was found the ceramic material was unable to withstand the temperature rise during welding hence the idea was dropped.

(2) Use of steel plates

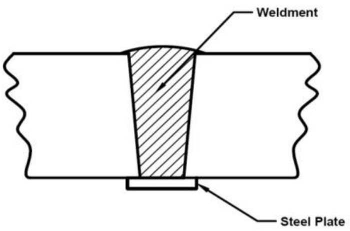

Fig. 8: Use of Steel Plate

All the above steps repeated using steel plate strips; it was found that the plates could sustain the temperature which was failure in first case. But there was a problem that the weldment flow was unequal causing improper seam profile.

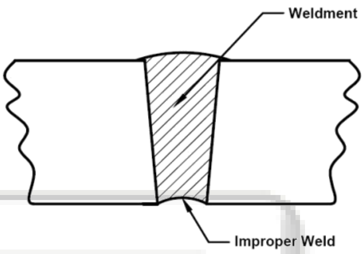

Fig. 9: Improper Weld.

(3) Modification of backing strip

In this we machined the groove in backing strip for proper flow weldment leading to sound weld. After taking the welding trials with the modifying backing strip the results were satisfactory.

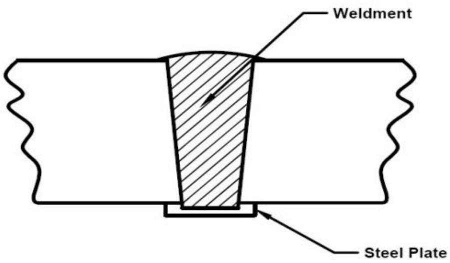

Fig. 10: Grooved Steel Plate

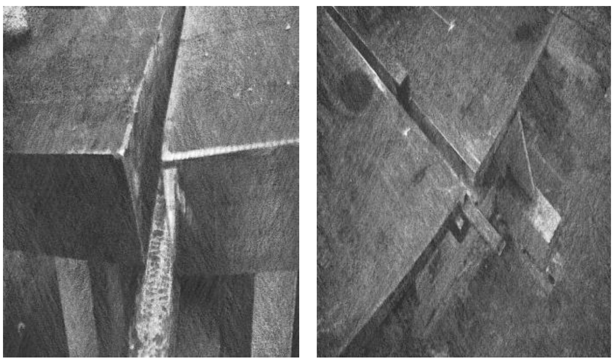

Fig. 11: Grooved Steel Plate

5) Comparing the models with the real world.

Sr. No.	Processes	Cycle time		Remarks
		Double side weld	Single side weld	
1	Setup	2hrs	1hrs	Idling of Rolling machine and crane avoided
2	Outside Welding	8hrs	12hrs	At a stretch
3	Chipback grinding & P.T	3.5hrs	-	Eliminated
4	Chip Back Welding	5hrs	-	Eliminated
5	Rerolling	2.5hrs	0.5hrs	Reduced shape distortion
6	Miscellaneous Time	2.5hrs	1.5hrs	Handling ,Procurement of consumables etc
7	Total Cycle time	23.5.5hrs	15hrs	Cycle time reduction by 37%

Fig. 1: Comparison of single and double weld

6) Defining changes that are desirable and feasible.

Considering the design change in weld joint Optimized Angle for single side v was calculated by welding engineer to minimize consumable required.

Backing strip (steel plate) size finalized with min material requirement

For holding of the backing strip a separate Setup fixture to avoid manual jacking was thought of which was designed by us. During this we have taken into consideration the following points.

a. Thickness of the shell.

b. Weight of the fixture.

c. Shape of the fixture

d. Provision to adjust skew of offset of shell

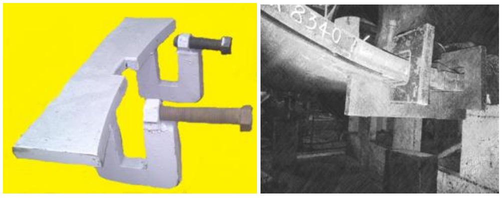

Fig 12. Fixture for Single Side Weld

7) Taking action to improve the real world situation.

The trials were taken as shown in the above figures i.e. ceramic strips, steel plates and the final optimum method was finally used which was of with a backing strip plate with a single side weld.

Sufficient no of holding setup fixtures were made to ensure the continuous welding over the provided welding stations.

To ensure the uniform amount of heating in the seam area conventional methods of heating the material by the gas burner was replaced by electrical pad in heating.

Timely data was collected of the following parameters

- Preheat temperature
- Interpass temperature
- Post heat temperature
- Electrode material
- Flux material
- Current
- voltage
- Ovality
- Depth chart

IV. MANIFESTED CATWOE

A. Clients – Who are the beneficiaries or victims of this particular system?

- Workforce for reducing the cycle time and the Customer as they will get a speedy delivery.

B. Actors – Who are responsible for implementing this system? (Who would carry out the activities which make this system work?)

- Fabricators, welders, technical people, shop supervisors are the employs who carry out the setup process.

C. Transformation – What transformation does this system bring about? (What are the inputs and what transformation do they go through to become the outputs?)

- Change in the setup and welding methodology leading to time saving ultimately productivity improvement eliminating NVA's.

D. Worldview – What particular worldview justifies the existence of this system? (What point of view makes this system meaningful?)

- NVA's avoided, setup process changed, time saving, energy saving and fuel saving.

E. Owner – Who has the authority to abolish this system or change its measures of performance?

- Welding engineers and the production team

F. Environmental constraints – What are the constraints and limitations that will impact the solution and its success?

- AMR (additional material requirement) i.e. for the backing strips.
- Design and procurement of the new fixture.

V. RESULTS AND DISCUSSIONS

After successful implementation of single side welding concept the aim set forward of productivity improvement was achieved to a great extent.Enlisting below are the major advantages after implementation of this new concept:

- Tack free setup was successfully achieved resulting in saving of valuable consumables like welding electrodes used for tacking, fuels i.e. LPG for the preheating and post heating, time leading to idle rolling machine and the crane, energy of the workforce etc.
- NVA's such as Chip back grinding, Chip back P.T, Chip back Welding were completely eliminated resulting in considerable saving of time, resources and energy.
- Since the shell ovality was reduced due to firm fixture, it helped to reduce time required for shape correction in rerolling operation.
- From the calculations it was found that the cycle time of a single shell fabrication has been substantially reduced to 37% of the previous one.

VI. CONCLUSION

In this way the soft systems methodology targets organizational business and process modeling and identifies unstructured problems as well as identifying non-obvious problem solutions in a holistic view. Specifically, this approach provides the possibility of more clearly capturing the change that is necessary to improve the productivity of the shop. Applying this methodology to the welding method shows the potential of SSM application in the real course problems.

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