APPLYING LEAN CONSTRUCTION TO LOSS CONTROL

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ABSTRACT

Losses can be defined as economic and non-economic valuation of the different effects (psychological, legal, functional, environmental, etc.), due to waste, defects and damages in the workplace. Losses can be human, economic, institutional prestige, competitiveness, customers and markets, among others. Loss Control and Lean Construction contribute to their decline, so an optimal method by integrating the two systems is proposed in this paper.

It is intended the use of complementary elements of the two systems, to show the contribution of both in the achievement of the optimal integrated methodology so that we make profits and give credit to companies that contributed in achieving this goal. A methodology is proposed for focusing on the integration of Lean Construction and Loss Control, in order to the alternative theory "Working near the edge" proposed by Gregory A. Howell, Glenn Ballard, Tariq S. Abdelhamid and Panagiotis Mitropoulos, based on the work of Jens Rasmussen.

KEY WORDS

Lean construction, loss control, accidents, incidents, safety

INTRODUCTION

Loss control is the systematic and auditable management of injury prevention efforts, occupational diseases and loss of assets through decentralized allocation of responsibilities. This control is to eliminate or minimize waste, defects and damage in the production process.

The Loss Control System proposes Safety programs are geared to the prevention of all incidents, not only to prevent injuries and deaths as have been occurring in recent decades. Proposes reducing the "near miss" to reduce the "effective" and, therefore, losses are controlled.

Losses due to waste, defects and damage are the result of failures, omissions and weaknesses of systems, programs and processes.

DISCUSSION

Howell, Ballard, Abdelhamid and Mitropoulos explained that the framework proposed by Jens Rasmussen in Cognitive Systems Engineering offers a broader and more powerful view of the relationship between individual and work environment, and of the primary factors that lead to incidents. In this model, represented in Figure 1, the way work is done migrates away from the organization's boundary (fear) of economic failure and the individual's boundary of (distaste for) excessive effort

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(Figure 6.3 page 149, Rasmussen 94). It also describes the accidents, defined by Rasmussen as "loss of control", occur when work migrates to the boundary of functionally acceptable behavior and control is lost. This process was reflected in the last paragraph of the description of the Mechanical Contractor's program. Rasmussen argues that "...the result will very likely be a systematic migration toward the boundary of acceptable performance and, when crossing an irreversible boundary, work will no longer be successful due to "human error." (Page 149, Rasmussen 94). Safety programs are designed to counter the pressure to move into an area where control can be lost.

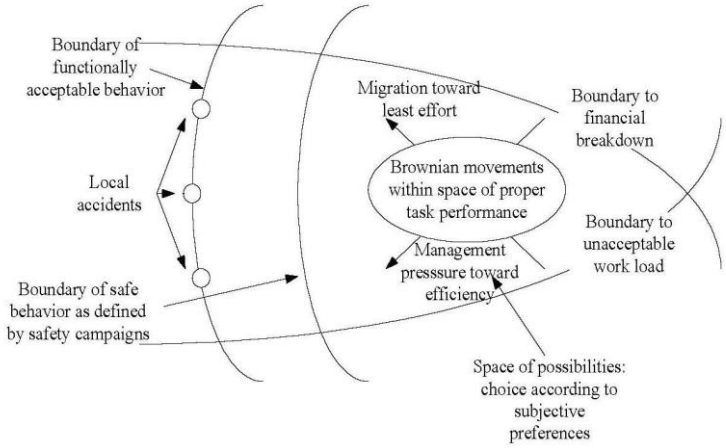

Figure 1: The migration of work toward loss of control. (Figure 6.3 Rasmussen 1994)

"*Rasmussen's approach recognizes that people adapt to the circumstances and suggests that helping them develop and apply their judgment will be more successful than simply following rules. Rasmussen's model for causation leads to a three step approach to safety as shown in Figure 2. The actions taken in each zone are described in relation to an incident where a worker was injured when a wrench slipped while removing a toilet.*

Zone 1 - IN THE SAFE ZONE: Enlarge the safe zone through planning the operation. NB: Identifying hazards in an operation assumes that the operation has been designed.
Zone 2 - AT THE EDGE: a) Make visible the boundary beyond which work is no longer safe (a hazard can be released) and teach people how to recognize the boundary. (Don't use an open end wrench on stuck nuts.) b) Teach people how to detect and recover from errors at the edge of control. (Increase pressure slowly when nuts are stuck or use a striking wrench to break them loose.) This may require practice in "simulators".
Zone 3 - OVER THE EDGE: Design ways to limit the effect of the hazard once control is lost. (Plan for what will happen if the nut breaks loose suddenly or the bolt breaks. Wear gloves.)" (Howell, Ballard, Abdelhamid and Mitropoulos 2002).

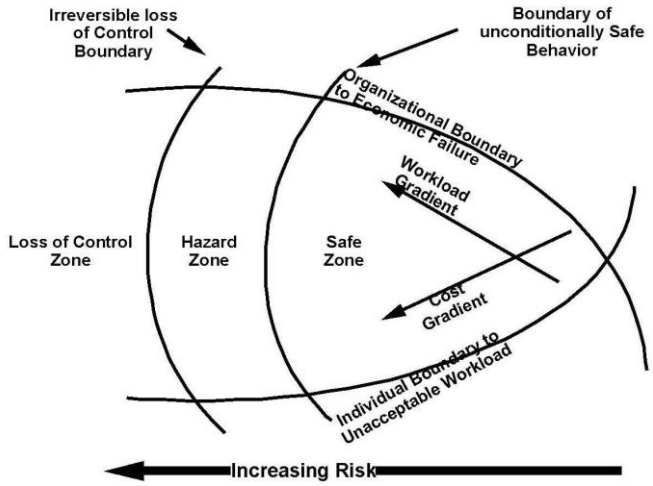

Figure 2: Three Zones of risk. (Howell, Ballard, Abdelhamid and Mitropoulos 2002)

LOSS CONTROL SYSTEMS

Key elements of these systems (Brioso 2010) are:

- Leadership and management.
- Critical tasks procedures and analysis.
- Investigation of accidents and incidents
- General promotion

It defines the Loss Control Director as a full-time professional who reports to the General Manager. The Safety Committee is chaired by the Safety Director2 and assumes no responsibility for the operation of the loss control program, which operates as a unit of counseling / monitoring. The Loss Control Director participates in the Safety Committee and coordinates its activities with the Safety Director.

The Safety Committee reviews reports of incidents / accidents and verify the degree of acceptance of responsibility for monitoring, conducting site surveys that can detect physical hazards, application of the rules and all evidence of unsafe working practices.

In the analysis of critical tasks and procedures, realistic goals are defined for the amount of work. The process of the definition of objectives should involve all team members, since are part of their goals. We define the time period in which the progress and achievement of objectives are evaluated. It should show that they worked in teams and with employee participation. All analysis must be filed. It should show that the tests and procedures are updated when changes occur.

In the analysis of critical tasks, exposure to potential losses and verification controls to prevent them must be recorded, these must also be incorporated into the procedures and signals. It must present the central file with master pages of the task analysis. It must prove that the results of these tests were communicated to staff.

It is required to have a system for reporting and investigating accidents and incidents. It must show formats and research methodology. Should involve the area

supervisor and line foreman. Staff should be trained in research methodology. It should show that root causes are being investigated, these are classified by potential severity and likelihood of occurrence. A File must be submitted including monitoring reports and corrective actions. It should show that directors and supervisors are involved in the investigation of the A / I serious, within 24 hours, and meetings are held to analyze the causes and propose remedies. It should show if they register and distribute the reports and action plans identified in these meetings. To display the file reports of accidents and incidents, which must include the corrective actions taken and progress reports made. These files should be easily accessible and be in sight at least two years.

Emphasis is given to the General Promotion of Loss Control System, a responsible for promotion should be appointed, as well as other employees should be assigned the job of cooperating. The panels should be located in areas where workers can read it at least once a day. The information must be renewed according to line planning. The publication of indicators and statistics of Loss Control System is provided as a way to promote the program and motivate staff in continuous improvement, compliance with standards and compliance with the objectives of the program. Critical issues are those that require more promotion to reduce more frequent accidents that require greater awareness by the workers. These issues should be selected according to reports of accidents / incidents, inspections and observation tasks. Must be shown that there is a system with procedures for making awards or recognition for compliance with safety standards. Also for those who contribute with suggestions, incident reporting, proposals for improvements and publications.

LEAN DESIGN

Within the Lean Project Delivery System, the Lean Design phase begins once Project Definition has aligned purposes, criteria and concepts (Ballard and Zabelle 2000).

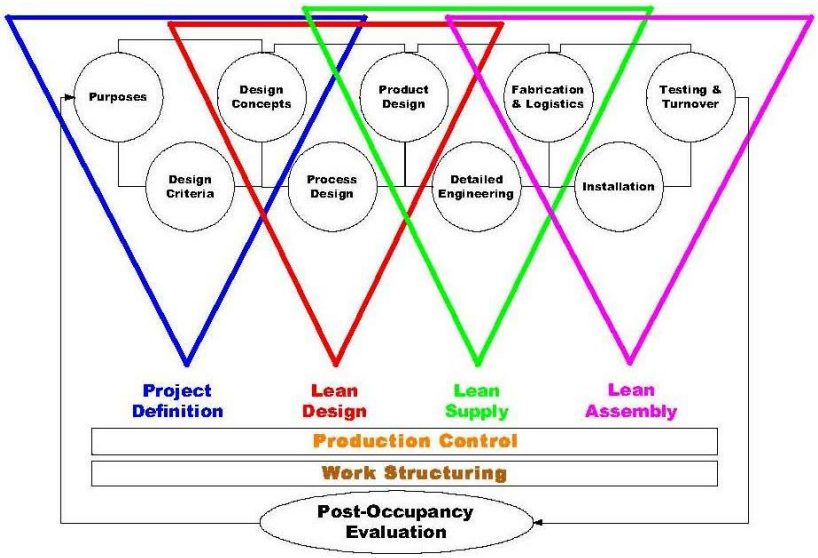

Figure3: Lean Project Delivery System (Fig. 1, White Paper # 10 Glen Ballard y Todd Zabelle 2000)

It ends when product and process design have been produced and themselves brought into alignment with the Project Definition elements. In rough order, the steps are to:

- Organize in cross functional teams
- Pursue a set based strategy
- Structure design work to approach the lean ideal
- Minimize negative iteration
- Use the Last Planner system of production control
- Use technologies that facilitate lean design

In this paper we propose that the Safety Director and Loss Control Director are involved from step "Organize in cross functional teams". It must include statistical of the Constraints Analysis of the company, comply with safety legislation, incorporate concepts of loss control system and integrate the alternative theory "Working near the edge" (Figure 4).

In other words, it must incorporate this new approach on constructability to develop the safety plan.

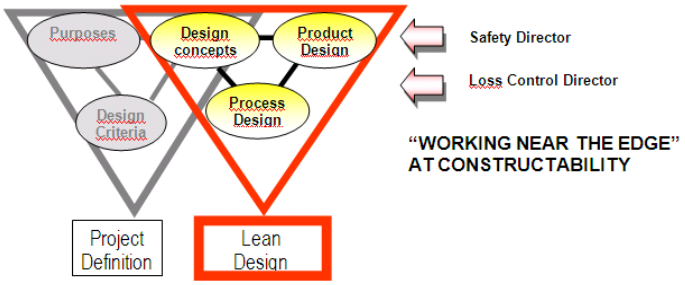

Figure 4: "Working near the edge" in Lean Design

LEAN CONSTRUCTION

The programming focuses on the optimal management of resources so that activities can begin on the date stated and with no lack of resources such as manpower, machinery, materials, etc Ballard (G. Ballard 2000).

Resource scheduling is complemented with a constraints analysis that could delay the start of an activity. It should monitor the constraints, as examples of them we have the preparation and approval of updated plans, the permits and authorizations municipalities, agreements with the neighbors, legal requirements, etc.

LAST PLANNER SYSTEM

The Last Planner System is a tool that helps us to improve the flow of scheduled activities, reducing the variability that exists in construction projects, therefore it helps us to better compliance activities.

Considers the people involved in programming, who will run more directly the activity, which are: production engineers, supervisors, subcontractors, foremen, safety director, etc.

We suggest the additional participation of Loss Control Director, as according to the Loss Control System, he has control over the incidents and losses they cause. The Safety Director and Loss Control Director must be trained to incorporate the new approach to construction safety, "Working near the edge". So we will have, an effective collaborative planning using constructiveness, engaging and involving participants with clearly defined responsibility for each activity or constraint.

MASTER PLANNING (GENERAL SCHEDULE)

Establishing timelines and milestones of the overall schedule, it is a list of all activities without going into details, selecting the proper construction process, according to the budget and available resources.

The Last Planner System depends on this stage to be successful. Besides defining the production systems to use, we must also clarify organizational aspects of the project, such as safety, contract management, human resources, administrative issues, logistics, etc. It is noteworthy that safety legislation still requires us to focus on a risk management standard, however, we can define the organizational aspects of the system, "Working near the edge" to be applied in the Lookahead.

LOOKAHEAD

The Lookahead is the second level of planning, it is done in the medium term and has an horizon depending on the type of project, normally should be done 4 to 6 weeks, depending on the duration of the project, the complexity, time of supply, etc. This was done to take action in a time interval close to the activities undertaken. Never lose sight of the General Schedule and verify compliance.

Lookahead main objective is to control the workflow and the correct sequence of activities already thought out and reflected in the general schedule. It must consider all aspects that affect or could affect each activity like logistical issues, coordination with office for updating plans, human resources, information for the choice of labor, etc.

Requirements for the lookahead:

- It must be started from the General updated Schedule. Do not miss the milestones established in the General Schedule (GS), so that the GS always go according to the maximum period of project implementation.

- It must be developed with the participation of the performer. Should involve all those agents who are to be responsible for the execution of tasks, such as contractors, foremen, etc. Safety Director and Loss Control Director will play an important role. According to safety legislation, Hazard Identification and Risk Assessment have to be done, taking preventive and corrective measures to the level of risk (high, medium or low). This is a statutory constraint. Assuming that the methodology "Working near the edge" has not yet been used in the company, Hazard Identification and conventional Risk Assessment can serve in the baseline to complete the three-tiered strategy of this new approach:

1) IN THE SAFE ZONE: Enlarge the safe zone through planning the operation using First Run Studies. Identify the various boundaries and the appropriate way to work in relation to them, then check the actual method against the plan. Working further upstream, the concept of boundaries and the coping behavior required near them should better inform designers how to reduce accidents through product design.
2) AT THE EDGE: a) Make visible the boundary beyond which work is no longer safe (a hazard can be released) and teach people how to recognize the boundary. b) Teach people how to detect and recover from errors at the edge of control.
3) OVER THE EDGE: Design ways to limit the effect of the hazard once control is lost.

An initial equivalence between the two methodologies is shown in Figure 5.

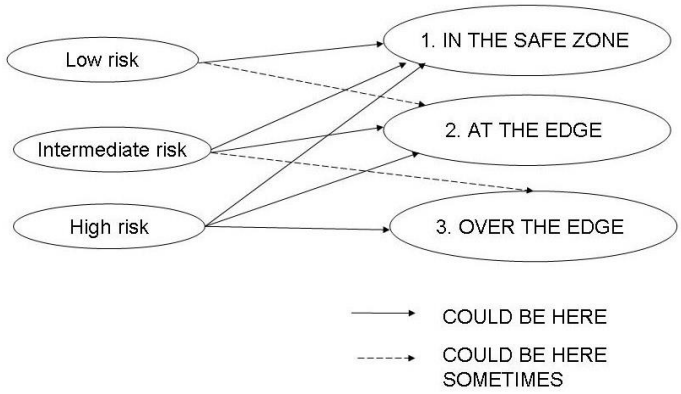

Figure 5: Conventional Risk Levels vs. Levels New Approach

- The conventional Low Risk means that the worker may be in the safe zone level of the new approach, and sometimes you can be on the edge. The worker will learn to recognize when you are on the edge and take action.
- The conventional Intermediate Risk means that the worker can be at the level of safe zone on the edge and sometimes it can be in the area outside the control of the new approach. The worker will learn to recognize when you are on the edge and outside the Control Area and what measures should be taken in each case.
- The conventional High Risk means that the worker can be at the level of safe zone at the edge or outside the Control Area of the new approach. The worker will learn to recognize when you are on the edge and outside the Control Area and what measures should be taken in each case.

It should be noted, that after applying the methodology in several works, you can adjust the analysis to consider in the design of the work system under these concepts. The safety performance and productivity may improve as we learn from accidents, incidents and how to extend the safety zone after application of the methodology.

- It must have an appropriate time window for the project.

- It has to be updated at least weekly.

The Lookahead should be clear to all people involved, who must be committed and be responsible for compliance with mandated activities. Thus, the schedule can be met safely.

In the Lookahead we should clearly determine what are the Constraint lifted, and also identify the resources needed for treatment.

CONSTRAINTS ANALYSIS

When scheduling Lookahead activities, we submit them to an analysis that aims to make items absolutely turned to start it without problems or delays. Usually the constraints on construction are of type:

- Design: Involves any updating of project plans so these are considered on time and any changes can be anticipated. Doubts may arise in the technical specifications or concerns in detail of the plans. You must also update the safety plan following the methodology "Working near the edge".
- Materials: All necessary materials to begin an activity must be available at the right time and not increase your inventory.
- Labor: You must define the crew for each activity, the date of entry of the workers, and have their documentation in order a few days in advance. Furthermore see the issue of insurance, uniform and safety equipment.
- Equipment and Tools: The teams that are planned should be at the right time, as well as personal tools, which vary depending on the activity.
- Quality: To have the controls ready for each item to preserve the quality of each activity.
- Activities Predecessors: Check if predecessor activities are already carried out according to programming.
- Permits or Licenses: Bear in mind if you need local permits for the activity or signing documents.
- Water, electricity, neighbors, union, etc.
- From Lookahead Constraints, we can separate a group that only deals with the logistics (materials, equipment, tools), known as resource analysis.

We note that for the effective enforcement of the safety plan and the new approach proposed in the methodology "Working near the edge, we must add the following constraints:

- Comply with safety legislation, incorporating the mandatory forms for reports of accidents and incidents, reporting loss ratios, hazard identification and risk assessment, investigation of accidents and incidents, among others. Do not start activity if it has not complied with the completion and submission of

forms according to the rules, otherwise, the Ministry of Labour inspectors can stop work and fine the company, which could cause a delay in programming.

- Incorporate concepts of Loss Control System and verify that they have fulfilled their requirements as a condition for the start of each activity.
- Integrate the alternative theory "Working near the edge" proposed by Gregory A. Howell, Glenn Ballard, Tariq S. Abdelhamid and Panagiotis Mitropoulos, based on the work of Jens Rasmussen and verify that they have fulfilled their requirements as a condition for the start of each activity.

WEEKLY SCHEDULE

From Lookahead we highlight the first week and meet scheduled activities for this week as a priority objective, this is why this week should be better detailed. It is also important to plan the use of buffers.

When you lift all constraints of an activity, this is already completely ready to be programmed and executed, the weekly plan is based on activities free of constraints, so the need for each responsible to fulfill his function.

Could be as constraints of the week, those that are easy to meet and it is not necessary to have so much time in the field, such as cement, aggregates, a compactor rental, etc. These constraints should be reviewed, prepared and check their availability in advanced, so you only have to place the order at the right time.

The safety training scheduled for the week must be met to 100%, the new approach will be applied looking for the workers to get involved and expecting contribution in the design of the risk areas.

Reasons for Noncompletion form (detailed and categorized), Constraints Analysis form, other forms and documents must be designed according to the new approach proposed in the methodology.

DAILY SCHEDULE

The daily schedule consists of developing a program that includes production activities carried out in the day, so we come to the last level of planning, where we give the finishing touches. Also, methodology "Working near the edge" should be considered as well as a meeting with the workers at the beginning of the day to review this new approach, applied to the tasks of the day. We must verify (Howell, Ballard, Abdelhamid and Mitropoulos 2002) that workers are always able to answer the following questions:

- Where are you—in what zone?
- What is the risk or hazard you now face?
- What can be done to prevent releasing the hazard?
- What can be done to reduce harm- should the hazard be released?

It is important to make measurements of performance, not just crew, but every staff member, see if a worker is productive, to assess whether he has the right tools, see what factors influence productivity, such as health, climate, water shortages, poor

diet, lack of motivation, lack of safety planning, etc. The new approach "Working near the edge", will facilitate such work.

PERCENT PLAN COMPLETE (PPC) AND PERCENT SAFETY PLAN COMPLETE (PSPC)

In order with the aim of this paper, we propose specific criteria for the output of the planning process, which can be measured in the PPC.

Percent Safety Plan Complete (PSPC) can be defined as the number of planned safety activities completed divided by the total number of planned safety activities, expressed as a percentage. Safety is mandatory, legally and ethically, for this reason PSPC must be 100%, then it is important to define Safety Activities accurately.

REASONS

In order to what was said by Glenn Ballard, the reasons categories which will be used on the Case Study "Next Stage Project" do not promote identification of root causes (Ballard 2000). Consequently, it was proposed to use the elements of the Activity Definition Model as the primary categories and also to provide a guide for reasons analysis that will facilitate identification of actionable causes. The primary categories are directives, prerequisites, resources, and process. In this paper, we recommend to follow Ballard's proposal, specially the process category (Figure 6).

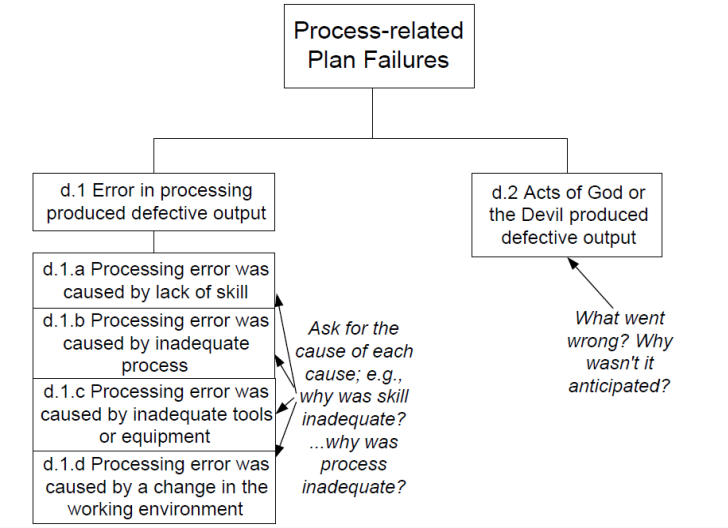

Figure 6: Reasons Analysis Hierarchy-Process The Last Planner System (Fig. 10.5, Ballard 2000)

CONCLUSIONS

Construction is a risky and variable work, and the performance of companies using conventional and regulation methodologies has stalled or could halted. Proposed integration of methodologies "Working near the edge", "Loss Control System" and "Lean Construction System" recognizes that the construction sector workers work in areas of risk or, as indicated by the new approach, "near the edge ". To make the proposed system effective, it is necessary to propose a baseline for the standardization of procedures for the integration of conventional methods with the new approach and to enforce safety legislation. For these reasons, the adoption of a new definition of

risk, in which employees participate proactively in the planning of work, could make the security zone detected by the workers, and thus can reduce accidents and incidents. The dangers will continue, but the conduct of workers could change. Companies that are convinced that these new systems are effective will be needed, then we can make actual measurements of performance. The adaptation of the proposed methodology for each company, each country will depend on factors such as safety legislation, available resources, etc. but above all, the conviction of its leaders to break with the paradigms and the Status Quo.

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