한국해양공학회 2004년도 추계학술대회 논문집 PP.40~44

Constraints Evaluation for Ship-building Industry

Dong-Sik Back* · Duck-Young Yoon**

*Dept. of Naval Architecture And Ocean Engineering Graduate School of Chosun University Gwangju

**Dept. of Naval Architectu re & Ocean Engineering Chosun University Gwangju

KEY WORDS: TOC(Theory Of Constraints),Heuristic, Shipyard Planning, Constraints condition, DBR(Drum-Buffer-Rope),HBCM(Hull block construction method manufacturing levels)

ABSTRACT: *A fact that limits a company's ability to achieve more of its goal is referred to as a "constraint." shipbuilding industries need to identify and manage constraints. The theory of constraints is evolved out of the problems of bottleneck formation. This happens and is conserved for the formulation if various real time problems for arriving standard uniquely addressed problems If, for example, the goal of a shipbuilding industry is to make money now and in the future, it is suggested that TOC will enable th mangers of the company to do so. TOC, focuses the organization scare resources on improving the performance of the true constraints, and therefore the bottom line of the organization. An attempt is made for the implantation of the theory into real world shipyard decision support mechanism*

1. Introduction

A factor that limits a company's ability to achieve more of its goal is referred to as a "constraint." shipbuilding industries need to identify and manage constraints. It may be relatively easy intellectually to recognize that an organization must have a constraint, but it may be quite another thing to positively identify it. In situations when the constraint can be easily identified, the five steps process of on-going improvement provides the steps necessary to deal with the constraint. In situations when the constraint is not as easily identified, the thinking processes provides the tools necessary to identify the core problem or core conflict and the tools needed deal with it effectively.

The theory of constraints is evolved out of the problems of bottleneck formation. This happens and is conserved for the formulation of various real time problems for arriving at standard uniquely addressed problems. The theory of constraints(TOC) is an overall management concept that has its basis in the entire cross-section of manufacturing environment. TOC recognizes that organizations exist to achieve a goal Using the TOC is designed to produce. If, for example, the goal of a shipbuilding industry is to make money now and in the future, it is suggested that TOC will enable the mangers of the company to do so.

Author : Dong Sik Back Faculty of Naval Architectural Engineering Chosun University in Kwang-Ju

062-230-7881 seartist@hanmail.net

TOC, focuses the organization scare resources on improving the performance of the true constraint, and therefore the bottom line of the organization. Here a chain of analogy th help illustrate why this is an effective way to get immediate results. In shipbuilding company can be though of as a chain of dependent events that are linked together like a chain. The activities that go on in one "link" are dependent upon the activities that occur in the preceding "link" TOC says that management needs to find the weak link in the chain since "a chain is only as strong as its weakest link."thus, a company should focus on "chain strength"(not link weight)by working to strengthen the weakest link- the constraint. An attempt is made for the implantation of the theory into real world shipyard decision support mechanism

2. Industrial constraint addressed a shipbuilder

The shipbuilding industry has many constraints points of constraints in shipbuilding. We consider of space, time ,crane equipment movement, human movement, material handing equipment movement.

a) **Space**: In Shipyard P.E(Pre-Erection) area is taken into account, namely length and breath. One side is arranging blocks in P.E area laod and also consider of next blocks.

b) **Time parameter**: In Erection Sequence time constraints are

LNT(Last Network Time), the ENT(Earliest Network Time) and critical path. The constraints are very important criteria for any engineer dealing with planning aspects and working for the optimal and expedited production in the industry. Especially in the shipbuilding industry the prompt delivery of the final product is very important else the penalties will undercut the financial stability of the shipyard. Therefore order to make system has to keep the delivery time.

C) Crane Reach : The shipbuilding industry uses many blocks. When a block is to be moved out of crane's available degrees of freedom we face the problem of constraints. The cranes of different type have different direction of movement and purpose, e.g Jib Crane and the Goliath or Gantry Crane.

d) Human movement. The human accessibility to the work could be hindered by the avsence of manhole, inconvenience for the reach evaluation, unavailability of illuminace and daylight, lack of working space.

e) Material Handing System. An assembly factory makes heavy blocks out of reach of the work at Pre-erction area. The organizational unpredictable interference like industry strikes, unexpected transient weather variation, delays to delivery to client. In shipyard have many constraints.

3. Constraints Shipyard Hull Block Construction method manufacturing Levels Network Bottleneck Problem

Recent shipbuilding company research for ower satisfaction and reduce manufacture lead-time. The function of manufacture lead-time can enhance the other shipbuilding competition. The shipbuilding industry is a large production multi-level probability of bottleneck formation during regular work flow pattern. The soaring international competition needs advanced production optimisation and load distribution. The concentrative P.E Area & Erection process always receive high load.

Specifically, Erection network gathers all final flow block. Erection network make criterion scheduling. In shipyard planning is a nerver ending process. The constraints(Erection ability) have fixed ability. Hence, this describes our problem. This paper make adjustment to use TOC solved to shipyard constraints process.

3.1 Concept of TOC(Theory of Constraints) in DBR(Drum-Buffer-Rope)

Theory of Constraints is a work-in-progress. It continues to evolve into new area as people discover. its broader applicability and it also continues to improve in delivery in established a as people refine their approaches. TOC have many methodologies. This paper concerned with DBR(Drum-Buffer- Rope)method. DBR is named after the three essential elements of the solution, the drum or constraint, the buffer or material release lead duration, and the rope or release timing. The aim of the solution is to obtain a robust and dependable process that will allow us to produce more, with less inventory, less rework/defect, and better on-time delivery-always. The out come is that we protect the weakest link in the system against process dependency and variation and maximize its effectiveness. This the Fig. 1 show the simple DBR production.

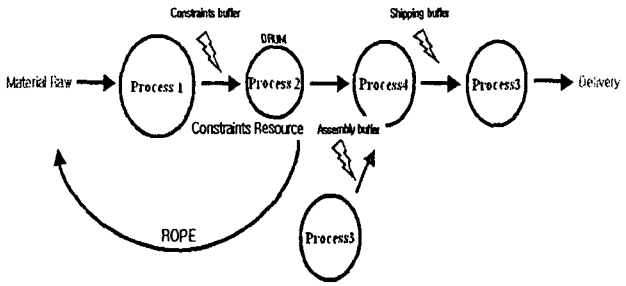


Fig. 1 Definition sketch for horizontal porous membrane

Push system is decides first process ability. But in DBR Raw materials input speed decide to constraints process

① Drum: How to operate to maximize constraints resource make to control flow

② Buffer : Decide to time buffer

③ Rope : Input raw material time connect to process constraints resource time

Theory of constraints in general can be summed up in just two words: focus and leverage. These two words, work out through the mechanics of Drum-Buffer-Rope. The concept of our "rules of engagement" which is to define: the system ,the goal, the necessary conditions, the fundamental measurements,

and the role of the constraints. The introduced the concept of our "plan of attack" - the five focusing steps that allow us to define the role of the constraints.

(1) Identify the system's critical points.
(2) Decide how to Exploit the system's critical points.
(3) Subordinate everything else to the above decision.
(4) Elevate the system's critical points.
(5) If in the previous steps a critical point has been broken Go back to step1, but do not allow inertia to cause a system constraints.

The identification the constraints, in any normal production process, either manufacturing or service based, there will be work-in-process everywhere, especially if the plant is run as a balanced line. Even more so, if you use some from of MRP(Material Resource Planning) or ERP(Enterprise Resource Planning), tracing the weakest link always is difficult. In this situation every step looks like the weakest link with large amount of working and waiting time at each stage.

There are three suggested ways :
(1) Find the steps with the longest waiting time for work to be complete.
(2) Find the step that most often causes.
(3) Nominate something.

3.2 Adjust TOC(Theory of Constraints) in shipyard scheduling

In shipyard, we use zone construction method.(Fig. 3) as different types of work are required, a product-oriented breakdown of ship construction work should accommodate the following zone-oriented methods. Optimum blocks(zones) are key objective as the basic for control in Hull Block Construction Method.

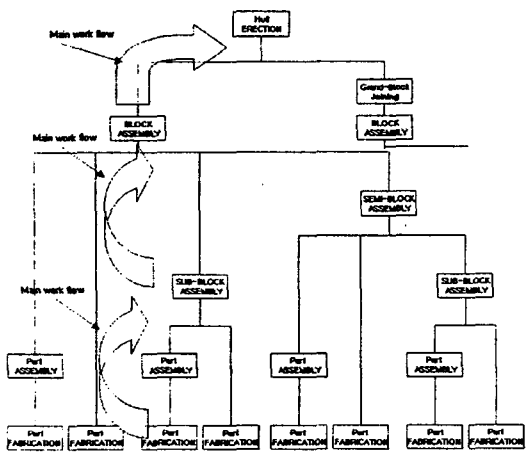
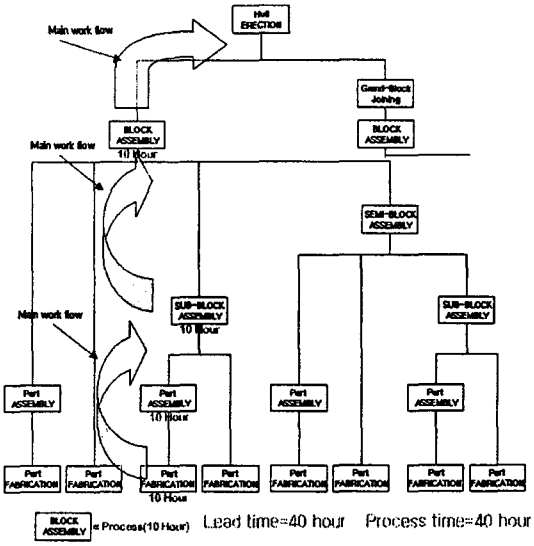


Fig. 2 Hull block construction method manufacturing levels

Adjust DBR think subordinate everything else to the above decision consideration of constraints resource (constraints process) and connect un-constraints (normal process). This method need to Time Buffer in DBR use, constraints buffer, shipping buffer (Case of shipbuilding P.E Area buffer), assembly buffer. Constraints buffer exist in front of constraints process. In order to prevent from the constraints of shortages. Shipping buffer protect the delivery day but in this paper show the P.E Area is designated as buffer. Assembly buffer connects previous assembly process to next assembly process.

All shipbuilding process make to schematize model. We hypothesize process have a same ability and process-time(10hours), in aspect of Modern heuristics. We make three case Firstly any other process don't setting buffer. Secondly all process buffers supports or are variants kind of JIT(Just-In-Time) Thirdly, constraints resource buffer. Shipping buffer and assembly buffer, affirm all cases just calculate main work flow.

Case 1. Any other process don't setting buffer.



Result : Lead time = 40 hour , Process time = 40hour

Fig. 3 Include Process time HBCM

Case 2. All process setting buffer.

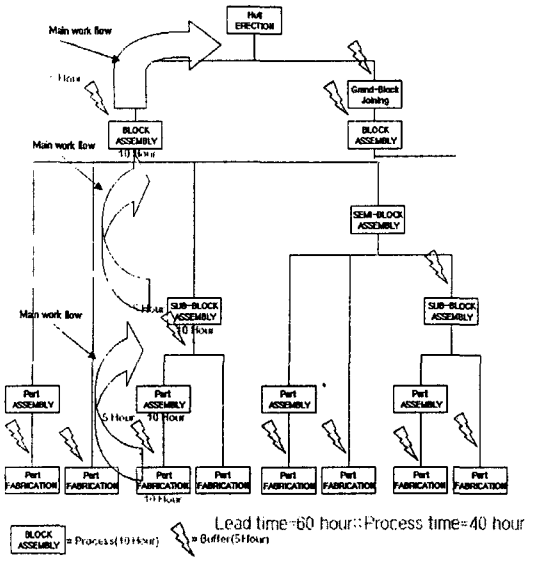


Fig. 4 Include JIT Process HBCM

Result : Lead time = 60 hour , Process time = 40hour

Case3. Constraints resource buffer ,Shipping buffer and assembly buffer.

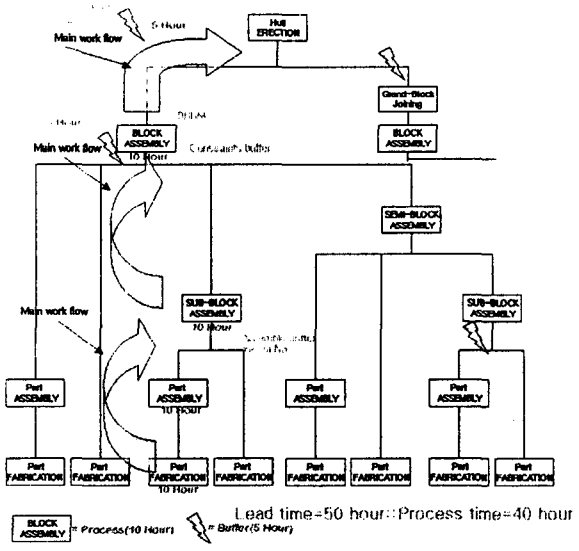


Fig. 5 Include DBR Process HBCM

Result : Lead time = 50 hours , Process time = 40hours

Analysis result lead time & process time show the case1 lead time shows the 40 hours also process time 40hours, but this process don't preserve Murphy (kind of stop process). Problem of process stops all process. and then don't keep delivery time.

The case 2 is JIT(Just In Time); for ward all process setting buffer. During 5 hours will preserve disconnecting process. But setting all buffer in each process means make inventory and spend many lead time. and so, we must mange all buffer-system this meaning managing decentralized management

Case3 is DBR. DBR controls the constraints buffer and shipping buffer. It is the special case of setting assembly buffer for connecting constraints resource to un-constraints resource. If attack Murphy disconnecting constraints flow Constraints spend constraints resource buffer. Before out of constraints we must recovery process. DBR such have two buffer because have advantage. Buffer management is very easy and simple.

Comparison DBR and JIT.

DBR has less stock and short lead -time. In shipyard Drum is block assembly level. Because of variations in working times and or jigs, special flat and special curved blocks are not assembled in assembled in facilities designed for work flow where starts and completions are in unison and connect all three process (Part assembly, Sub block assembly, Semi-block assembly) Last delivery is Hull Erection Hull step at erection level of hull construction All process in shipyard planning deemed basic.

DBR Planning

Lets consider of CCR(Capacity Constraints Resource) decide process speed. CCR(in this paper show the block assembly) treat drum. If increase is limited. Management connecting part fabrication to block assembly. Repeat explain first part fabrication process speed identity. block assembly. CCR rope length show the Prat fabrication process time to block assembly process time Also Rope consist of all process time and constraints buffer.

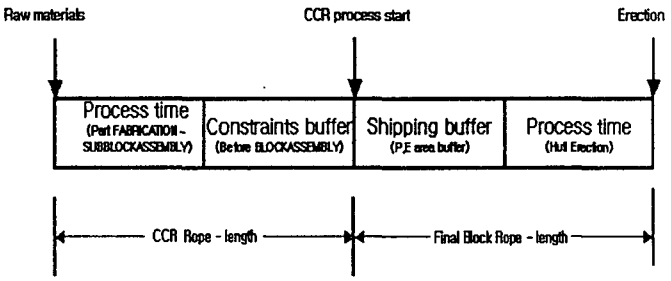


Fig. 6 Decide to Rope length.

Management the control operator and it gives to decide worktime in each process, input raw materials and keep delivery time.

In shipyard scheduling in DBR three steps.

(1) Make Drum scheduling- Shipyard base line Block assembly decide scheduling.
(2) Decide buffer = In shipyard important point decide shipping buffer and constraints buffer. Because shipbuilding block is very heavy and its relocation is very difficult.
(3) Redact Rope scheduling.

HBCM scheduling three step decide to input raw materials.

5. Conclusions

We covered a great many facets of constraints optimization problems and provides a survey of some of the attempts to treat these problems. The theory of constraints production solution- drum-buffer-rope. A mechanism the allows us to rapidly and significantly increase output and quality, shorten lead-times and work in process, while improving on-time delivery. Adjust TOC(Theory of constraints) in shipyard scheduling search after total optimization. If setting constraints buffer we show the buffer effect. This concept of first step improve planning. If an attempt is made for combination of the other shipbuilding planning system might find weak-link. and then make strong link.
In future study can be attempted in adjusting real shipbuilding planning data and then consider of multi-process planning to use TOC critical chain.

Acknowledgements

Author would like to express their gratitude to the school of naval architecture and ocean engineering of Chosun University for their assistance. suggestions and support in writing this paper.

References

Zbigniew Michalewicz, David B. Fogel. " How to Solve It : Modern Heuristics pp232-268

Thomas E. Vollman William L.Berry D. Clay Why bark, "Manufacturing Planning & Control Systems(4th Edition)" pp790-802

최광식 (2001). "기업 회생을 위한 패스워드 TOC", pp 136-195.

정남기 (1999). "TOC 제약 경영"

김기동,우상복, 한형상 (2001), " 자원 제약을 고려한 조선 산업에서의 탑재 일정계획 연구", IE Interface 제 14권 제 3호, pp 218~226

http://www.dbrmfg.co.nz/Production.htm (2003) A Guide to Implementing the Theory of Constraints (TOC)

Richard Lee Storch, Colin P. Hammon, Howard M. Bunch, & Richard C .Moore(1978). "SHIP PRODUCTION" pp60-70

Kin Jin Kyu(2000). "Solution of the Drum-Buffer-Rope Constraints Scheduling Problems in incorporated by MRP/JIT" 산업경영 시스템 학회지 제 23권 제 59집

Jong-Yoon Young, Geum-Sik Jo(1998). "Knowledge-Based vs Constraints-Based scheduling : A case study of Gate allocation problem" 한국 전문가 시스템 학회 논문집 제 4권 제 2호.

Yoon Duck Young, Ranjan Varghese Tae Kyu, Bae Chung Kon, Koo(2004). Erection Sequence Generator for Ship Building :33rd International conference on computers and industrial engineering, Jeju, Korea.