

# **REFLECTIONS ON MONEY AND LEAN CONSTRUCTION**

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## **ABSTRACT**

Money is a particularly tricky resource to manage because it comes with its own set of rules. Value is created by the application of cost concerns to choices in design. Likewise cash flow considerations during construction may lead to adjusting design to minimize risk of schedule overrun. Here again the role of money is to help clarify value for the client. In some cases the speed of the project may be limited by the rate of cash flow and while managing to assure no overrun how ever small is simplified by reliable work flow, some additional time should be added to the schedule to account for variations in cash flow. By contrast, if a precise and rapid completion date established early in the project is important to an owner, steps must be taken to insure the project is not sensitive to disruptions which might cause the project to be late. In this case, a buffer of additional money is prudent. In either case, the problem of matching cash flow to construction demands is eased by reliable workflow.

## **KEY WORDS**

Money, financing, lean construction, lean production, production management

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## INTRODUCTION

Koskela proposes that flow and value considerations must be added to the current activity centered model of construction (Koskela 1992, Koskela and Huovila 1997). Great strides have resulted from the development of flow management concepts, most notably the Last Planner approach developed by Glenn Ballard (Ballard 1994, 1997, Ballard and Howell 1997). Significant research has been undertaken by academic and private institutions to develop and extend techniques relating to flow and to better understanding how value is developed and delivered. Efforts are now underway by researchers to better understand the concept of waste defined by Engineer Ohno's design criteria for a production system; instant delivery of a product meeting customer requirements with nothing in stores (Ohno 1988). Womack lead the lean movement by telling the stories of the impact of lean on the auto industries and companies in a variety of settings (Womack et al. 1991, 1996). Taken together the work of these seminal thinkers created a new appreciation for the importance of reliable flow and value creation.

Efforts to improve the speed and reliability of work flow now extend from the assignment level on site back through the lookahead process, and up to the master schedule which results from work structuring decisions early in design. Likewise the concern for speed and reliable flow now includes delivery from supply chains. These efforts have been devoted almost exclusively to improving the flow of information and resources to reduce system wide waste. Efforts to improve information flow have reduced the difficulty of handling the second most difficult resource, paper. But little thinking or action has been directed to the trickiest and most volatile resource, money.

Value generation is less well understood. Roughly speaking it means figuring out what the client wants (after identifying who in fact is the customer). Efforts are underway to improve the quality of design brief and front end planning. But the process of value generation and the role of money in it, is still something of a mystery.

This paper is a first step to consider the money in the lean setting. We propose to consider money as a resource with special attributes but subject to the application of lean thinking within those attributes. Likewise we will offer some thoughts on money and value.

## MONEY AND VALUE

“What the client wants” defines value. What we want is constrained by what is possible but the line between a dream and a possible desire is hard to draw. The authors, mindful of the wisdom of Mick Jagger<sup>3</sup> believe that the consideration of money is key to finding that line and what is on each side. We propose that value is created by moving aspects of the project from “Dream” through “Possible desire” to “Included Feature.” Value is assuring each category in fact contains the right features or functions. A feature or function is in the right

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<sup>3</sup> “You can't always get what you want, but if try sometimes you just might find, you get what you need.” (Jagger and Richards 1969)

place if it has been considered and the “cost”<sup>4</sup> of shifting it into the next category is less than it is worth in comparison with other features and functions. Included features are either what the client wants or are waste. But what a client wants is always in relation to other choices and these may not be within the project boundaries. A recently recorded example based on the experience of the first author on rebuilding the most architecturally challenged house in Idaho.

“Shall we rebuild the kitchen, send our kid to college or go to Botswana and look at the elephants?”

Here I had to balance the cost of each alternative against the cost of the others. Reducing the cost of one alternative may increase the chance it will be selected only because a higher value to cost ratio is now available in comparisons to others. This suggests that one rule for value is that it is established in comparison to other desires within the “Dream” and “Possible Desire” categories.

Another example illustrates the role of money in clarifying value. On the same project a decision was made to have vaulted ceilings throughout larger rooms to match the living room. This implied a post and beam form of construction. This desire was questioned as the budget figures came in from the contractor. He suggested we shift to pre-manufactured trusses for the garage, family room, office and one bedroom.

Accepting the change in the garage and bedroom was easy. Attic trusses allowed some storage over the garage and the bedroom ceiling was not considered important. Scissors trusses were suggested for the office and family rooms because the sense of the vaulted ceiling could be maintained by slopping the bottom chords up to the center. So the choice was made to use scissors trusses in the office and family room. Immediately after the decision was made, I realized that the bottom chord of the trusses would be too low for the windows planned for the family room. (I had a firm commitment to always have decisions made far enough in advance so that the contractor would not be delayed. So this was a problem, at least for me.)

I called the contractor and told him of my discovery. He assured me that there was still time to make the decision and suggested that I put my money on those things that mattered. He further observed that the family room was at the heart of the way we lived and we should consider the choice carefully. The architect made essentially the same observation and added that the office was a smaller space and did not have the high windows of the family room. He suggested I use the scissors trusses there. Again he pushed me to consider what was important. I decided to use post and beam in the family room and scissors trusses in the office. As a result I understood far better what I really wanted in comparison. This suggests a corollary to the first rule: A large budget may conceal value by allowing features to be included which do not add value.

(I had assumed that the scissors trusses would be symmetrical and so the ridge line in my office would be off center to allow for a the porch on the south side. This was not a big deal but I was a little concerned about it. I mentioned this to the truss company engineer and he

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<sup>4</sup> Cost here may not be simply monetized. It may be a trade between other features of almost equal value to the owner.

designed the truss so the soffit over the porch was flat and the ridge centered in my office. This was an unexpected gift that makes the office far nicer than I had expected. As Mr. Jagger opines....)

This illustrates the role of money in the value creation process. The design process has been described as an ends/means negotiation carried on by representatives of different value sets. Here one aspect of means, the consideration of cost, forces choices between alternatives and those choices reveal relative value. Turned the other way, visits to large opulent houses often illustrate that unlimited budgets do not create value because choices can be made without consideration. Carried to the extreme, each brush stroke could be such a choice. Looking back, I wish I had been more careful in painting the kitchen because almost all of the walls are covered with cabinets.

## **MONEY AND THE IMPORTANCE OF FLOW**

### **PRELIMINARY RULES**

Flow is understood around money. Cash flow is important to all parties<sup>5</sup>. Managing the money in a project is a value creating act for most clients. Here we mean the interim financing and payments as well as the total cost. Some background.

Budgets matter because most clients have a limit on what they are willing to spend. This may be imposed by limited access to money although this is rarely as fixed as people would have you believe. More reasonably, more money is always available but the cost of that money may exceed the value resulting from its application. “You could borrow it from your in-laws but then...”

Or the limit on spending is determined by the income created by the project. Developers are cautious to assure that the project cost not exceed their budget and are unlikely to revise their assessment of income up during construction because of a change in the market or the effect of some value adding decision. Far more typically they want some one else to assure the cost side of the project business plan stays fixed and they secure access to that amount; plus of course some contingency they do not reveal to the designer and contractor (Tavistock 1966).

Financiers are anxious to assure the project will be delivered on budget AND that the cash flow is very predictable. Here we begin to see the importance of reliable work flow on financing. Why do the financiers want a predictable cash flow? Because they know that money standing still and not available to others wastes away due to interest. Resources, pipe in a lay down yard, can be understood as money standing still but the same level of concern is rarely present because a pipe lay down yard filled to capacity appears to reduce some other potential problem which might cost more.

Failing to complete the project on time is one such problem. The first rule for money then is, “Never let it stand still.” The conventional wisdom corollary is “Spend it as late as possible.” This is because unlike other resources such as bricks, money flows out during

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<sup>5</sup> We omit those people for whom money is no object and its management of no concern. Our review of the literature and experience suggest there are in fact very few such people and they are not rich. Gandhi and Jesus come to mind.

construction and in on completion. Clients or financiers are sensitive to the moment when the flow reverses.

Some owners try to spend the money as late as possible by slowing payment to gain interest on the money. In response contractors take steps to assure they do not have their money standing still and not available to others. In other words, they want to get paid and be cash positive as soon as possible. This frees their money for other projects and growth. They can speed their cash by inflating early payments or, and here is the dangerous part, adjusting the way they do work to assure more comes in than goes out. Pressure for production is often applied to activities that earn more money than they cost, regardless of the impact on the project or the continuous flow of money.

The fact that a project is worth nothing to the owner until it “works” and the flow of cash is reversed gives the contractor great power to hold up the owner for changes and extras (Williamson 1979). In response, owners hold money back so the contractor always has an incentive to complete the project. These games around cash can have serious negative consequences for all involved. Perhaps this suggests another rule. “Shortage of cash alone does not reduce project cost or add value and it may lead to significant waste.”

Finally, financiers understand the rules of money. They know that access is cheaper to get in large chunks and in advance and when the risk to the lender is low. They also prefer a steady flow of money into the project so they do not have to maintain a buffer of non producing cash. (Of course they can always put it in some short term money market account but the return is low compared to the expected return from other sources.)

## **CASH FLOW AND PROJECT MANAGEMENT**

Practices vary in different countries and under different financial conditions but these practices all rest on the same urges to make the total expenditure fixed and the flow of money predictable. Contracts can be drawn which attempt to assure no overrun and can shift the cost of unreliable cash flow to one party or another but these can have unintended consequences.

A series of cases illustrate the issues. These cases simplify the illustration of the relationship between cash and project management because the construction of this type of building is well understood. The cost and duration estimates can be quite accurate and the flow of work during construction quite predictable unless something unusual happens. Holding this issue more or less fixed allows us to better understand the relationship between money and production. All projects discussed are 24 story mid-rise apartment buildings.

The first case is funded by apartment owners. Figure 1 shows the duration of 36 months with the second activity, walls beginning when the structure is leaving the 19<sup>th</sup> floor.

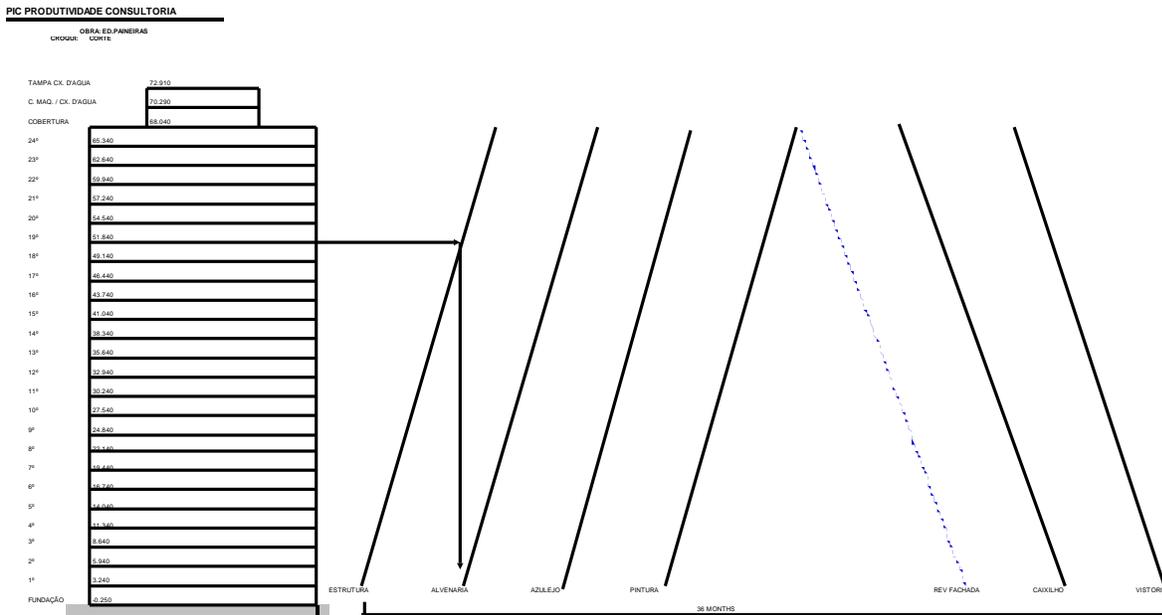


Figure 1<sup>6</sup>: Project Duration 36 Months

In this case, the project is to be completed in 36 months so the activities are widely spread. Money can come in relatively small chunks. This is an unusual case as owners of individual apartment provide the money as the project is being completed. The contractor receives a monthly fee of about 15% of the work installed. Additional investment from the contractor would be required to speed the work. In this case, since cash flow determines completion and the time to complete may be long and the date certain padded to account for potential variations in cash flow.

The next project is to be completed in 24 months. Again there is no variation in processing time for each activity. The acceleration is accomplished by starting the following activities on the 6<sup>th</sup> floor. See Figure 2 Below. More money will be required each month. So the developer takes this plan to the bank about 4 months before construction begins and “buys” the money for the project. The delivery is specified for each month based on the plan. Significant penalties will be applied if more money is required in any one month. The bank only offers this financing if the project is backed by another organization which posts a bond stating that it will complete the job under any circumstances. The developer must pay for this bond or have significant capital available.

This schedule is easy to accomplish, as there is still significant float between many activities. Let us pretend that this project is completed to plan, the cash flow is as predicted and move on to a real project.

<sup>6</sup> Operation 1: Estrutura = Structure, Operation 2: Alvenaria = Walls, Operation 3: Azulejo = Ceramic tiles, Operation 4: Pintura = Painting, Operation 5: Revs.Fachada = Facade /Curtain Walls, Operation 6: Caixilho = Glass Operation 7: Vistoria = Owners – Inspection/move in

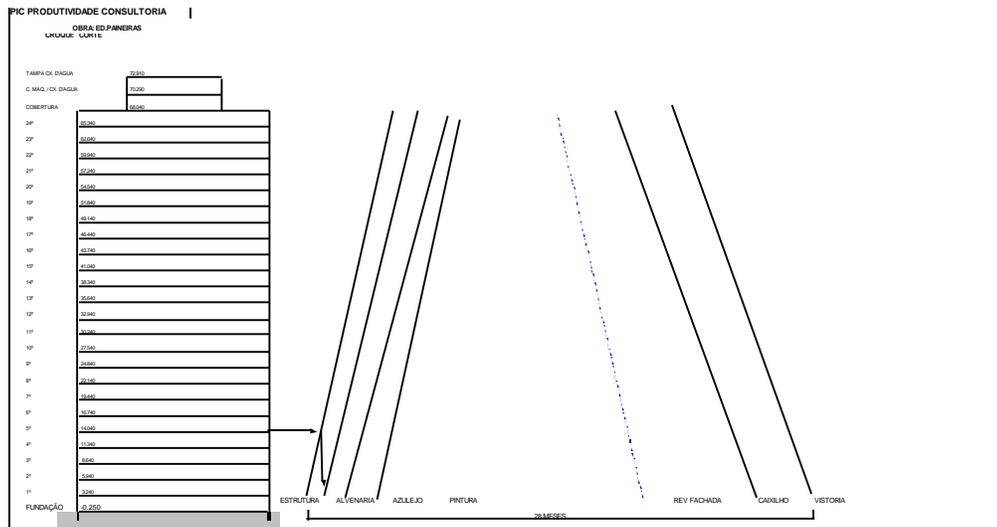


Figure 2: Project Duration 24 Months

Here the duration has been reduced to 18 months. The contracts are drawn so that everyone loses money if the project takes longer but levels of profit should balance the increased risk. Again, through extremely reliable planning the project is completed on target and the cash flow is smooth (see Figure 3).

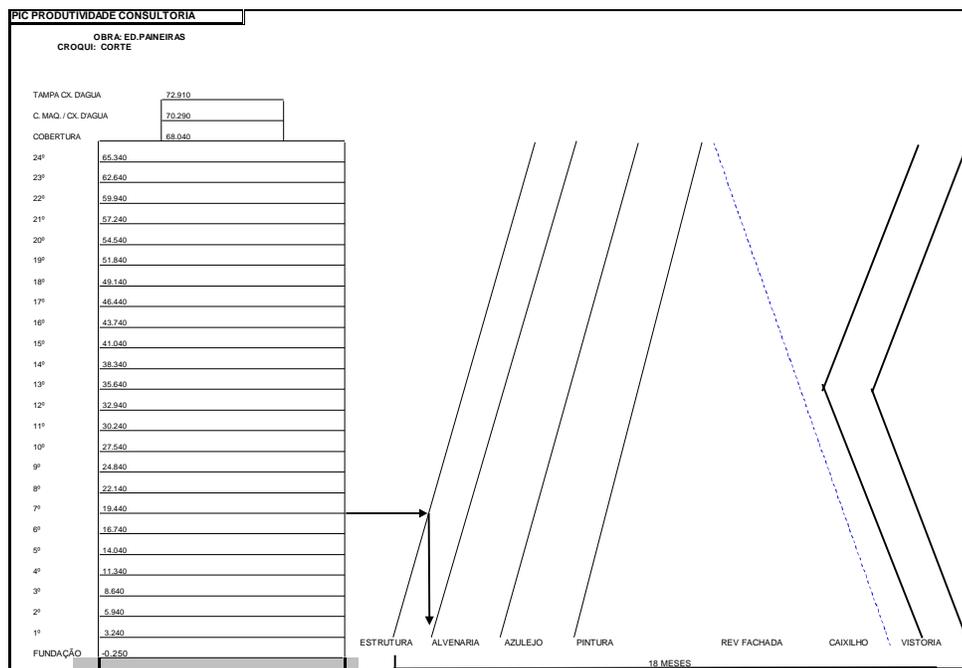


Figure 3: 18 Month Duration

But this is real life and God intervenes and it rains preventing the installation of exterior tiles. See Figure 4 on the following page. The bank does not pay when there is no progress but does charge for the use of the money. Stress abounds.

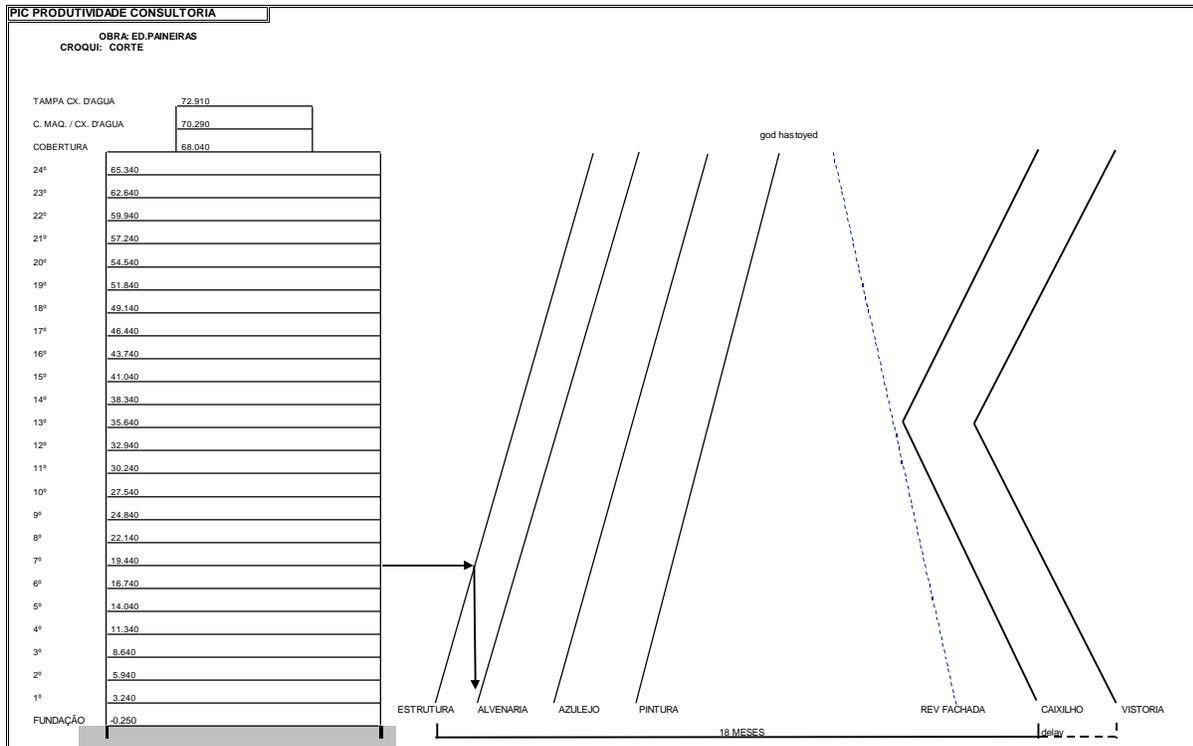


Figure 4: 18 Month Plan Delayed by Rain

Now the project is behind schedule and cash flow will be a mess. The problems may cause the project to run over the budget as well, and the delay will slow the moment when the flow out reverses. More money will be needed and faster to complete the project. How can this problem be ameliorated if not prevented?

One solution is to build the project more quickly using various lean techniques. Closer starts would be possible if the production rates are truly predictable, although at some point additional lifting capacity may be required. Essentially we could build a buffer of completed floors as a cushion. This would violate the rule of spending as late as possible in relation to the day the direction of flow changes.

A second solution would be to design out the potential for the problem either in the product by finding an exterior which can be applied in the rain (but probably not rain and during an earthquake) or by changing the installation process to allow tile to be applied simultaneously with interior walls. This may require an investment in research that may be hard to justify because it rarely rains. But the same innovation could cut total duration giving the developer a competitive edge.

Or we could buy insurance in some sense by securing a second source of financing which would support greater fluctuations. The cost of this solution could be compared with other

solutions. Indeed some banks offer additional funds for only small incremental charges if the amount is identified 20 days ahead of need.

## CONCLUSION

Financial considerations are central to disclosing value on a project. This is not to say every value can be monetized but the cost and timing of expenditure considerations provide insight into what the client wants. Managing money during construction is a tricky business because it is subject to stringent just-in-time inventory considerations. Financial instruments and institutions are sensitive to the waste which occurs when inventories are either too large or insufficient. They are less sensitive to the negative effects of a cash shortage, particularly on the orderly flow of work.

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