

Program Planning and Financing in MTO Manufacturing

MTO manufacturing is often project-based, where procurement and production activities do not start before an order arrives or a contract is awarded. Program manager's primary responsibility is to plan/schedule project(s) subject to limited availability of resources, such that certain performance measure (project makespan, or program cost) is optimized.

Established in the 1970s, ABC Inc. is a manufacturer located in St. Louis, MO. Its business involves military products, research and development, custom fabrication and Eagle 9001 quality assurance. As most of ABC's work is contract-based, its operations are mainly MTO, and project management plays a crucial role at ABC.

ABC's operations manager and project/program manager need to work closely to ensure multiple programs progress on schedule and under resource capacity. In the past, their focus has been mainly in limited machine capacity, e.g., the multi-purpose cutting machine and the paint shop. Financing of the ongoing projects was often not an issue. Only recently, ABC found that it often struggled with cash flow to support multiple ongoing programs, many of which require spending to procure/purchase raw materials, parts, components, or for other outsourcing needs. Borrowing is not as easy as it used to be, as most banks have tightened their lending policy due to detrimental economic environment. The project plan presented by the project manager was often rejected by the procurement department, there is not enough cash/capital available. As ABC's chief project manager put in this way:

"It is an embarrassing situation that in our Monday weekly meeting, we often found ourselves spending two hours fighting about which parts or components should be procured/purchased, while others have to be delayed."

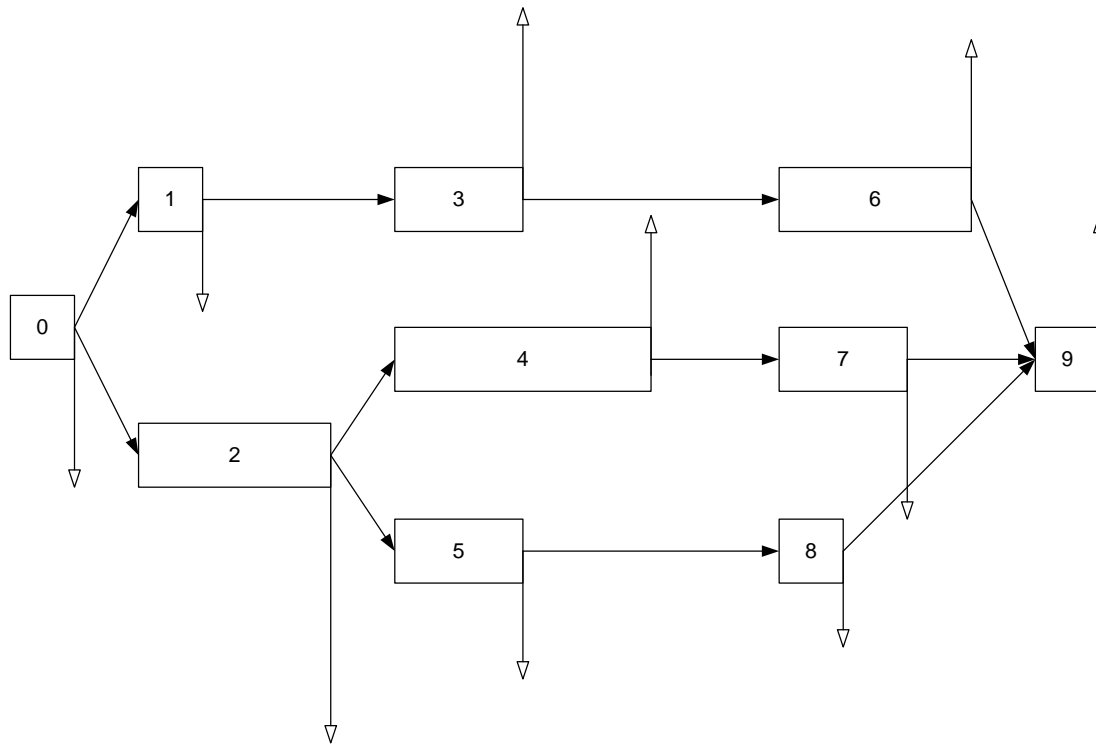
Fortunately, ABC's CEO immediately realizes seriousness of the issue and would like to consult from you, a researcher specialized in Supply Chain Analytics. After an initial review of the case, you make the following recommendations:

- The issue was caused by the lack of coordination between project management and procurement.
- Planning and scheduling of projects should focus not only on the shop flow stage, but also the procurement stage. That is, one needs a holistic view of all stages through a supply chain from procurement to production.
- To initialize a research project to develop optimization models for providing integrated decision support to project planning and financing. The project team consists of domain experts of ABC's project, procurement and finance managers, and you, as optimization modeling expert.

As a starting point, the Project Team comes up with the following information and data about a particular instance of the problem.

Project Network

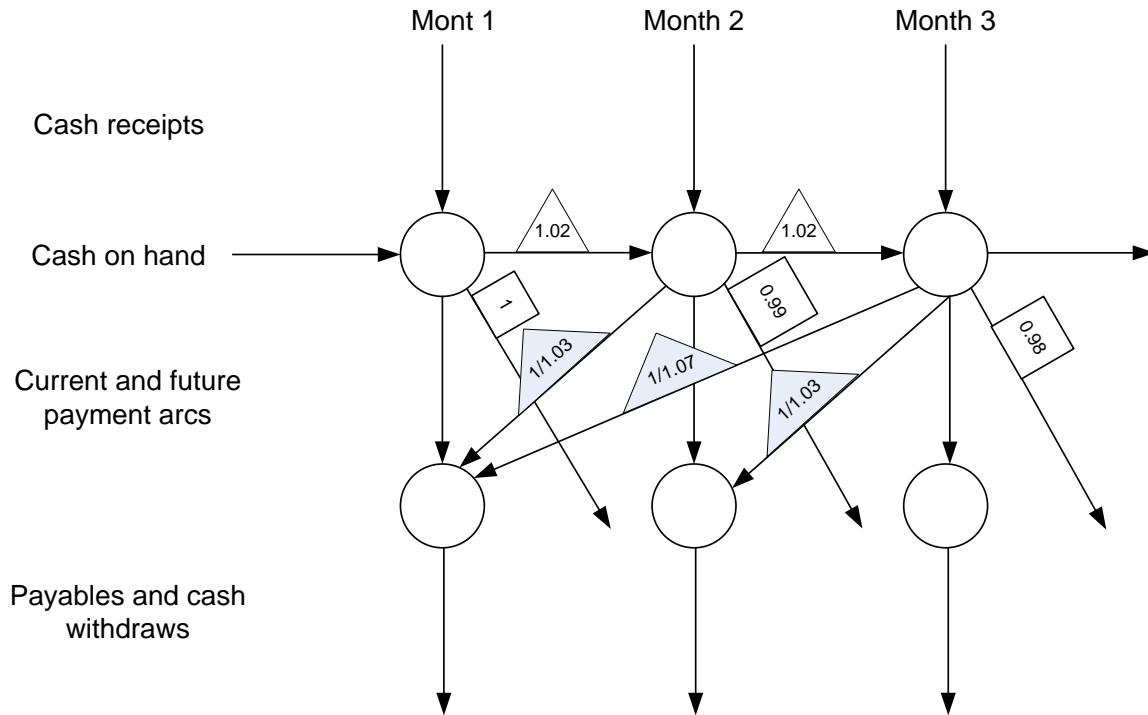
The project scheduling network consists of tasks/activities involved, as well as temporal (precedence) relationships among them. It can be described by an activity-on-node (AON) network with nodes representing activities, and arcs denoting precedence relationships. Each activity has either a positive or negative cash flow. Arcs with solid heads represent precedence relationships. Arcs with empty heads denote cash flow. Here we assume that cash flows occur upon completion of an activity. An upward empty headed arc indicates cash inflow, while a downward empty headed arc indicates cash outflow. The length of an arc suggests the amount of a cash flow.



Project Data

Activity	0	1	2	3	4	5	6	7	8	9
Duration (in month)	1	1	3	2	4	2	3	2	1	1
Cash Flow (\$)	-100	-100	-400	300	200	-200	200	-50	-100	300

Cash Flow Network



Arc costs are associated with the discounted value of \$1 and are denoted by squares. For instance, if \$1 cash is withdrawn today, its value is \$1; if \$1 is withdrawn next period, its value is 0.99 and so forth. Arc multipliers are associated with the interest rates and are denoted by triangles, with white triangles representing deposit rates and blue triangles representing borrowing rates. We allow delayed payment as often the case in practice. For instance, if period 1's payable is paid by funds in period 2, an interest rate of 1.03 is considered; if it is paid by funds in period 3, an interest rate of 1.07 is considered.

Financial Data

Discount rate: 0.01

Deposit rate: 1.02

Borrowing rate: 1.03 (next month), 1.05 (next two months)

Initial cash: \$50

Initial debt: 0

Ending cash: \$50

Ending debt: 0

Total borrowing limit: \$4000

Payable per month: \$300

Maximum borrowing limit per month: \$350

The team would like to answer the following questions:

- a. What is an optimal project plan (start time of project tasks, and project makespan)?
- b. What is a best financing plan to support the optimal project plan?
- c. What if the total borrowing limit increases to \$5,000, \$6,000, or more? What if the total borrowing limit decreases to \$3,000, \$2,000 or less?
- d. What if the max borrowing limit per month increases to \$400, \$450, or more? What if it decreases?
- e. What if there is zero monthly payable?