Simulating the Contributions of Cash Flow Components to the Real Value Creation Process

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Simulating the Contributions of Cash Flow Components to the Real Value Creation Process

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Financial managers have a need to analyze the contributions that various operating strategies and policies make in the creation of shareholder value. This paper uses a Lotus 1,2,3 program to make operational an integrated discounted cash flow (DCF) model developed by Gentry and Lee. The model integrates the cash flow contributions from short-run financial management (SRFM) variables and conceptualizes the key relationships among the SRFM variables. The program provides management a tool for analyzing the daily performance of any key variable and for determining the contribution it makes to cash inflows or outflows. The program makes it possible for management to simulate various operating strategies and policies; to analyze the performance of components that contribute to cash inflows and outflows; and to determine the operating strategy that creates the highest shareholder value. The program results highlight the need for management to use the uncertainty model for planning purposes because the certainty model may significantly overstate the value of the firm.
SIMULATING THE CONTRIBUTIONS OF CASH FLOW COMPONENTS TO THE REAL VALUE CREATION PROCESS

The strategic decisions of financial management are based on real economic determinants, such as market size, growth of the market size and share of the market, that create real value for shareholders. The contribution of these real economic based decisions to the long-run dividend stream is transmitted to the financial markets where it is discounted by investors, Williams [8] and Gordon and Shapiro [3]. In contrast, financial market theories such as CAPM, APT and OPT mask the fact that managers make decisions about how to operate in the factor and product markets of the real economic sectors [1].

Until recently the cash flow contributions of short-run financial management (SRFM) decisions were implicitly assumed to be imbedded in the discounted cash flow stream of the valuation models. Sartoris and Hill (S&H) [7], Gentry and Lee (G&L) [2], and Rappaport [6], have developed models that explicitly integrate the cash flow contributions from SRFM variables into a discounted cash flow (net present value) model. These models conceptualize the key relationships among the variables that contribute cash inflows and outflows. The models show that the real value of a firm can be increased or decreased by either a change in exogenous or endogenous variables, or a change in SRFM policies and decisions. The models are complex because they include a broad array of variables that contribute to daily real cash inflows and outflows. This generation of cash flows from operations is the basis for creating real shareholder value. The cash flow generating process is a dynamic nonlinear system where flows are changing
continuously. One objective of this paper is to use a Lotus 1,2,3, program to make operational an integrated discounted cash flow (DCF) model developed by Gentry and Lee [2]. The model is based on conditions of uncertainty and it incorporates the complex, dynamic and stochastic dimensions that are involved in the real value creation process. The model makes it possible to simulate various operating strategies and determine the contribution of each SRFM component to the total value creation process.

The objectives are to provide an operational overview of the computer program that highlights the primary management inputs and the key operating linkages that create value; to present separately the cash inflow and the cash outflow variables in order to show that the operating strategies and policies selected by management directly create or destroy value. The final objectives are to highlight the reports created by the program and to compare simulated valuation results generated under conditions of certainty and uncertainty.

Overview

To highlight the SRFM variables responsible for creating or destroying value, the DCF model is expanded to encompass daily cash inflows and outflows from operations. The variables that contribute to daily operating cash inflows (CI) and cash outflows (CO) are presented in Exhibit 1. In determining the net present value (NPV) of the cash flows, the DCF model discounts daily net cash flows (NCF = CI - CO) at a risk adjusted cost of capital. The timing and quantity of daily CI are closely related to the competitively determined credit
terms established with customers. The timing and level of daily CO2 are closely related to the credit terms established with suppliers. Additionally, numerous decisions are made daily that directly affect a company's net cash flow, e.g., collection and sales efforts, production and purchasing decisions, and short-term investment and borrowing decisions. Implementing these short-run decisions is what creates long-run real value.

Flowcharts of the cash inflow and outflow processes provide a general overview of the components that contribute to the real value creation process. Additionally, the flowcharts provide a framework for understanding the overall operation of the model and for observing how real value, NPV, is determined. Flowcharts of the cash inflow and outflow processes are presented in Exhibits 2 and 3, respectively. The exhibits also feature the major decision areas that determine whether there is an excess or a shortfall in cash flow.

The most obvious contributions of Exhibits 2 and 3 are the numerous operating variables involved in the value creation process and the complexity of the process. Secondly, Exhibits 2 and 3 illustrate the primary operating linkages involved in the value creation process. A brief discussion of the key linkages will highlight the operation of the model.

Exhibit 2 shows sales forecast and credit terms to customers are key inputs by management that result in determining cash inflows. Also Exhibit 2 indicates that collection patterns from customers and the related bad debt allowances are vital inputs by management in
determining the daily cash inflows of cash through collection of accounts receivable. Finally, the proxy for actual daily sales is determined from a normal distribution with daily forecasted sales as its mean. Under conditions of certainty, actual and forecasted sales are identical, but under conditions of uncertainty, actual sales are either greater than or less than forecasted sales. The impact of this difference between actual and forecasted sales is a primary cause of cash flow management problems and is manifested in a firm's production and inventory performance and its short-run borrowing and investment decisions.

Exhibit 3 indicates the inputs for daily forecasted sales and for unit production costs are key inputs in calculating daily planned finished goods inventory. In addition to the above input variables, inputs for trade credit terms and the payment patterns to suppliers play a key role in determining the level of accounts payable payments and cash outflow. The calculation of cash outflows is an aggregation of accounts payable, planned inventory and labor costs. Operating cash outflows are combined with short-term borrowing outflows in the computation of the daily cash outflows, which are then combined with the daily cash inflows to compute the daily net cash level used in calculating NPV.

A final objective is to compare daily cash inflows to outflows and determine if there is an excess or a shortage. Exhibit 2 shows that if the net cash level is greater than the target cash balance, the company's staff looks ahead at forecasted flows and determines how much to invest for n days. Alternatively, Exhibit 2 shows that if
there is a cash flow shortfall, the staff looks ahead at forecasted flows and determines how much to borrow for \( n \) days in order to meet the target cash balance. Borrowing is frequently related to forecasting errors and Exhibits 2 and 3 are designed to take them into account. For example, if actual sales are greater than forecasted sales and the accumulated inventory level, the firm may have to expand its operations which would result in the acquisition of additional raw materials plus overtime expenses related to labor and production. In the case of overproduction, when the resulting cash outflows are greater than the net cash level, short-term borrowing is used to finance the shortfall and to achieve the firm's target cash balance. Additionally, short term borrowing may be used to finance any additional holding cost related to the build up in unplanned inventory.

**Cash Inflow Variables**

Exhibit 1 showed various operating components that create real value, and Exhibits 2 and 3 provided a structural overview of these components. The next step is to identify specific variables and policies that cause real value to increase or decrease. The variables are classified into endogenous, exogenous and policy categories. Exhibits 4 and 5 present the variables that cause a change in operating cash inflows and outflows, respectively. Exhibits 2 and 3 provide the conceptual framework for the variables presented in Exhibits 4 and 5. These variables create the real value of the firm (NPV), which can be either positive or negative. The following discussion focuses first on the contribution of the cash inflow variables in
Exhibit 4 and shows that each variable can contribute to the real value of the firm.

The forecasted sales quantity information is endogenous to the cash inflow process and serves as the basis for generating proxies for actual daily sales. Daily cash inflows from the actual sales proxy are compared to daily cash outflows that emanate from forecasted sales plus inventory adjustments to determine the daily net cash level. If the net cash level is greater than the target cash balance, the company invests the excess cash in marketable securities, which adds incremental value to the total net cash flow. The net cash level and the target cash balance jointly determine the amount available for short-run investment. If net cash level falls below the target cash balance, it will cause short-term borrowing that results in an incremental reduction in the total net cash flow.

Credit policy terms directly affect the timing and amount of cash inflow. Depending on competitive conditions, one would usually expect the higher the percentage of credit sales collected early, that is at the end of the discount period, the higher the NPV, and the greater the creation of wealth. For example, higher discount rates may result in a speed up in cash inflows, which would create an incremental increase in firm value, or vice versa.

From the perspective of the exogenous variables, the level of product price has the most significant effect on the level of cash inflows. The level of short-term lending rates and the strategic planning horizon are determined externally and also effect the level of cash inflows. The competitive environment sets the stage for the
strategy developed by management, which in turn directly affects the level of cash inflows and the real value of the firm, Porter [5].

Cash Outflow Variables

Turning to the variables that cause changes in the cash outflow, which are presented in Exhibit 5, the endogenous variables play a significant role. The forecasted sales level is the most important variable because it drives production and purchasing costs. If actual sales are greater than forecasted, the accumulated finished goods inventory will be drawn down. Depending on the level and intensity of demand, the cost of replacing the inventory and meeting the demand may cause cash outflows to increase. If forecasted sales are greater than actual, the unplanned finished goods inventory will likely rise substantially, which leads to additional inventory holding costs. This forecasting error will cause short term borrowing to increase in order to finance either overtime production or the holding cost related to the buildup of unplanned finished goods inventory. The result is a decrease in net cash level which reduces the incremental contribution to the real value of the firm. The amount of planned inventory to be held as a buffer is an internal decision that can significantly impact cash outflows. Also the size of the cumulative forecasting error has an equally important effect on the level of cash tied up in inventory. Hall's [4] zero inventory strategy highlights the major significance of inventory control and planning on the level of cash outflows, and subsequently, on the real value of the firm.
Other endogenous variables that affect cash outflows are the initial and periodic fixed costs.

The trade credit terms negotiated with suppliers have a direct influence on the firm's payment behavior. The higher the discount terms and the shorter the discount and credit period the more rapid the payments to suppliers. The competitive environment determines the credit terms offered. Also terms associated with the repayment of debt determines when cash outflows will occur.

The exogenous variables that have the greatest impact on cash outflows are the costs associated with raw material and labor. Management can increase the firm's real value by purchasing comparable quality raw materials at a lower price per unit. Additionally the substitution of more efficient technology or equipment in the production process can lower overall cost. Value enhancement is frequently more difficult to achieve through production and purchasing efficiencies, but the theoretical gains are obvious.

The preceding discussion has shown that cash inflow and outflow variables can have a significant effect on real cash flows. By changing operating strategies and/or policies management can directly change the real value of the firm. A major task for management is to identify the operating strategies that will result in desired outcomes and simultaneously produce the highest incremental contributions to net cash flow. The computer program provides management a tool for simulating various operating strategies and determining the incremental contribution of each strategy to the real value of the firm. An important contribution of the G&L model is to show the sign of the
programmed relationships that exist between the numerous input variables and the respective working capital components. The sign of the programmed relationship are presented in Exhibit 6. In only a few cases is the relationship undefined. In these cases management has to provide the appropriate sign and information in order for the program to be operational. Exhibit 6 is quite valuable because it focuses on the relationships among short-run financial management variables that are seldom developed or discussed.

**Analyzing Performance**

The model generates six major reports that provide management projected daily information for tracking the performance of daily cash inflows or outflows and for analyzing the contribution of each variable to the total flow. The first report presents the daily collection of credit sales, the actual sales proxy which created them, and the date the cash is due. Also, cash receipts are reported separately for customers taking discounts and those not taking the discount. The second and third reports provide daily holding costs associated with forecasted excess inventory and daily forecasted accounts payable, respectively. The fourth report supplies short-term borrowing information that includes forecasted sales, actual sales proxies and the unplanned accumulated inventory. It reports the future borrowing costs that are related to under (+) or over (-) production and the total cost of current borrowing on the date the repayment is due. A fifth report contains the labor cost related to the forecasted sales plus any periodic fixed cost.
A sixth report is extremely valuable because it summarizes all of the major items reported in the previous five reports. The items are presented sequentially according to the actual date the projected inflow and outflow are scheduled to occur. Exhibit 7 presents an example of the summary report. These six reports provide management unique tools for analyzing the daily performance of any variable and the contribution it makes to the inflow or outflow of cash. The computer program makes it possible for management to simulate various operating strategies, analyze the performance of the components that contribute to the cash inflows and outflows, and select the operating strategy that creates the highest value of the shares.

A final report provides management the net present value information for comparing the performance of various planning scenarios under conditions of certainty and uncertainty. Exhibit 8 provides an example of eight NPVs that were generated in separate simulation runs under conditions of certainty and uncertainty. The NPVs are based on 12 months of daily discounted cash flow data. Each simulation uses the same information base and distributions which are reported in Exhibit 8. An analysis of the NPV results in Exhibit 8 shows the certainty model NPVs are relatively similar for all eight simulations. However, the NPV results generated under conditions of uncertainty vary significantly and they range from 10 to 60 percent smaller than the NPVs generated under conditions of certainty. The program results highlight the need for management to use the uncertainty model, because the certainty model may significantly overstate the value of the firm.
Exhibit 8 is an example of the extremely valuable information the program provides management for analyzing the performance of various projected operating strategies. The program makes it possible for management to experiment with various operating strategies and policies. The NPV information allows management to assess the validity of the assumption for the operating strategies and policies and determine the operating plan that makes the largest contribution to the real value of the company.

CONCLUSIONS

In planning, management designs operating strategies and policies that will create shareholder value. Because there are numerous variables involved in a firm's operations, there is a need for a user friendly computer program that allows management to determine the contributions that key operating variables and policies make to the value of the firm. The program presented is designed to meet this financial planning need. Several tentative conclusions result from the simulated example. First, the certainty model seriously overstates the NPV of the firm, which indicates the need for management to use the uncertainty model when assessing the contributions of operating strategies and policies. Second, the variability of the NPVs under conditions of uncertainty is much larger than under certainty conditions, which indicates the potential risk that exist in a firm's operations. Finally, the model shows that cash flow excess or shortfall is clearly related to forecasting errors. Thus, there is a need to account for forecasting errors in the planning process. In
summary, the operating process within a firm creates value and it is important to program these effects into a value creation model.
REFERENCES


### Exhibit 1

#### VALUE CREATION PROCESS

Components contributing to...

<table>
<thead>
<tr>
<th>Cash Inflow (CI)</th>
<th>Cash Outflow (CO)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations</strong></td>
<td></td>
</tr>
<tr>
<td>- Sales</td>
<td></td>
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<tr>
<td>- Collection patterns</td>
<td></td>
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<tr>
<td>- Collection effort</td>
<td></td>
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<tr>
<td>- Sales patterns</td>
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<tr>
<td>- Joint effects</td>
<td></td>
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<tr>
<td>- Credit terms</td>
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<tr>
<td>- Return on marketable securities</td>
<td></td>
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<tr>
<td>- Bad debt write off</td>
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<tr>
<td><strong>Operations</strong></td>
<td></td>
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<tr>
<td>- Raw materials</td>
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<tr>
<td>- Purchasing patterns</td>
<td></td>
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<td>- Payment patterns</td>
<td></td>
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<tr>
<td>- Production patterns</td>
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<tr>
<td>- Disbursement terms</td>
<td></td>
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<tr>
<td>- Holding and ordering costs</td>
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<tr>
<td>- Labor costs</td>
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<tr>
<td>- Services</td>
<td></td>
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<tr>
<td>- Compensating balances</td>
<td></td>
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<tr>
<td>- Research expenditures</td>
<td></td>
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<tr>
<td>- Delivery and storage costs</td>
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<tr>
<td><strong>Other</strong></td>
<td></td>
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<tr>
<td>- Short or long-term borrowing</td>
<td></td>
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<tr>
<td>- Sale of preferred stock</td>
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<tr>
<td>- Sale of common stock</td>
<td></td>
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<tr>
<td>- Sale of fixed assets</td>
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</table>

\[
\text{NPV} = \text{CI} - \text{CO} + \frac{\text{CI}(1+g) - \text{CO}(1+g)}{(1+r)^2}
\]

\[
+ \ldots + \frac{\text{CI}(1+g)^{n-1} - \text{CO}(1+g)^{n-1}}{(1+r)^n}
\]

**NPV** = Net present value  
**CI** = Cash inflows  
**CO** = Cash outflows  
**r** = Risk adjusted cost of capital  
**g** = Growth rate
EXHIBIT 2
CASH INFLOW PROCESS

Inputs for:
1. Product price, P(t)
   - Sales quantity range
   - Seasonality factor
2. Discount rate, d
   - Discount period, t_d
   - Credit period, t_c

The daily forecasted sales level, Q_f(t), is the mean of the daily actual sales proxy distribution.

Net Cash Level, CA(t), is defined as \[ \sum_{s=1}^{1} C_t(s) - CO(s) \]

The firm value, NPV, is defined as \[ \sum_{t=1}^{T} CA(t) \].

Immediate cash flow
n - Day lagged cash flow

Cash Outflow, CO(t) (from Exhibit 3)
Cash Inflow, CI(t)

Compute Interest Expense
Compute Net Cash Level, CA(t)

Compute Interest Income
Short-term Lending Rate, j

Short-term Borrowing Rate, k

Target Cash Balance, CM (from Exhibit 3)

Is CA(t) > CM ?
Yes
Invest in Marketable Securities for n days

n

n

No

Short-term Borrowing for n days
EXHIBIT 3
CASH OUTFLOW PROCESS

Inputs for:
1. The regular and overtime unit costs of raw materials: C(t), C'(t);
   labor: W(t), W'(t); inventory holding and ordering: H(t), H'(t).
2. Discount rate, c
   Discount period, \( t_p \)
   Credit period, \( t_f \)

Note: \( \text{UIA}(t) = \sum_{s=1}^{t} \left[ \frac{Q_f(s) \times [1 + n(s)]}{Q_a(s)} \right] \)

① Inputs for
② Trade Credit Terms
   Determine Payment Pattern, \( p(t) \)
   Short-term Borrowing Rate, \( k \)

③ Calculate Daily Accounts Payable
   \( t_{p}, t_{f} \)

④ Calculate Daily Planned Inventory Holding Costs
   \( t_{s} \)

⑤ Calculate Daily Planned Finished Goods Inventory, \( n(t) \)

⑥ Cash Outflow \( CO(t) \)

⑦ Determine short-term borrowing for financing inventory holding costs
   \( t_{b}(t) \)

⑧ Determine Initial and Periodic Fixed Costs \( FC, FC'(t) \)

⑨ Determine Target Cash Balance, \( CM \)

Stop

Forecast Sales, \( Q_f(t) \),
Actual Sales Proxy, \( Q_{a}(t) \),
and Inventory, \( n(t) \)
(from Exhibit 2)

Compute Unplanned Inventory Accumulation \( \text{UIA}(t) \)

Is \( Q_a(t) > Q_f(t) \times [1 + n(t)] \) + \( \text{UIA}(t) \)?

Is the forecasting error costs financed by the net cash level?

Is \( Q_a(t) > Q_f(t) \times [1 + n(t)] \) + \( \text{UIA}(t) \)?

Is the forecasting error costs financed by the net cash level?

Yes

No

Stop
Exhibit 4

VARIABLES AFFECTING CASH INFLOWS

Changes in Cash Inflows are Caused by
Changes in the Following Variables:

Endogenous

- sales level\(^1\) \(Q\)
- ex ante proxy for actual sales\(^2\) \(Q_a\)
- forecasted sales level\(^2\) \(Q_f\)
- target cash balance \(CM\)
- net cash level \(CA\)
- fraction of sales collected at end of discount period \(q\)
- fraction of sales uncollected \(b\)

Exogenous

- product price \(P\)
- short term lending rate \(j\)
- strategic planning horizon \(T\)

Policy

- discount rate available to customers \(d\)
- discount period to customers \(t_d\)
- credit period to customers \(t_c\)

\(^1\)certainty model
\(^2\)uncertainty model
Changes in Cash Outflows are Caused by Changes in the Following Variables:

**Endogenous**

- sales level\(^1\) \(Q\)
- ex ante proxy for sales\(^2\) \(Q_a\)
- forecasted sales level\(^2\) \(Q_f\)
- initial fixed costs \((FC)\)
- periodic fixed costs \((FC(\tau))\)
- unplanned finished goods inventory accumulation level \((UIA)\)
- fraction of raw material costs paid at end of discount period \((p)\)
- planned finished goods inventory as a percentage of forecasted sales level \((n)\)
- repayment period of short term borrowing \((t_b)\)

**Exogenous**

- raw material costs per unit\(^3\) \((C)\)
- other variable cost per unit\(^3\) \((W)\)
- average inventory holding and ordering costs per unit\(^3\) \((H)\)
- short term borrowing rate \((k)\)
- deferral period of other variable costs \((t_w)\)
- production period \((t_s)\)
- strategic planning horizon \((T)\)

**Policy**

- trade discount offered by suppliers \((c_i)\)
- discount period from suppliers \((t_p)\)
- credit period from suppliers \((t_f)\)

\(^1\) certainty model

\(^2\) uncertainty model

\(^3\) normal and overtime cost per unit
### THE SIGN OF THE RELATIONSHIP BETWEEN KEY INPUT VARIABLES AND WORKING CAPITAL COMPONENTS

<table>
<thead>
<tr>
<th>Input Variables</th>
<th>Target Cash Balance</th>
<th>Collection of Accounts Receivable</th>
<th>Planned Finished Goods Inventory as a Percentage of Forecasted Sales</th>
<th>Payment of Accounts Payable</th>
<th>Fixed Cost</th>
<th>Other Cash Outflows</th>
<th>$ Sales—Actual (Proxy) and Forecasted</th>
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</thead>
<tbody>
<tr>
<td>forecasted sales</td>
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<td>-</td>
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<td>production period</td>
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<td>+</td>
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</table>

$U = \text{undefined relationship}$

$^1$normal cost per unit

$^2$normal and overtime cost per unit

$^3$overtime cost per unit
### Exhibit F

**Summary Report for the Uncertainty Model**

<table>
<thead>
<tr>
<th>Month</th>
<th>Forecast Actual</th>
<th>Sales % Mod/Dis</th>
<th>Pay.-No./Mod.</th>
<th>Pay.-No./Dis.</th>
<th>Secondary Gain Hold.</th>
<th>Cost</th>
<th>Suppliers Labor/Lumber</th>
<th>Flow</th>
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</thead>
<tbody>
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<td>1</td>
<td>124</td>
<td>247</td>
<td>0.00</td>
<td>0.00</td>
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**Flow**
Exhibit 8

RESULTS OF EIGHT SIMULATIONS

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Assumptions

Credit Terms to Customers

\[
d = 2\% \\
t_d = 10 \text{ days} \\
t_c = 30 \text{ days}
\]

Bad Debt

\[
b = 1\%
\]

Production Variables

\[
t_s = 5 \text{ days} \\
C(t) = 5 \\
H(t) = 1 \\
W(t) = 4 \\
C'(t)/C(t) = 125\% \\
W'(t)/W(t) = 200\% \\
H'(t)/H(t) = 150\%
\]

Credit Terms to Suppliers

\[
c = 2\% \\
t_f = 3 \text{ days} \\
t_p = 10 \text{ days}
\]

Short-Term Borrowing and Lending

\[
k = 10\% \\
t_b = 6 \text{ days} \\
j = 8\%
\]

Cost of Capital

\[
r = 12\%
\]

Other Variables

\[
CM = 1\% \text{ of forecasted sales} \\
FC = 10\% \text{ of forecasted sales} \\
FC(t) = 500 \\
\max n(t) = 5\% \text{ and } \min n(t) = .5\% \\
q(t) = 31.05\% \\
t_w = 10 \text{ days}
\]