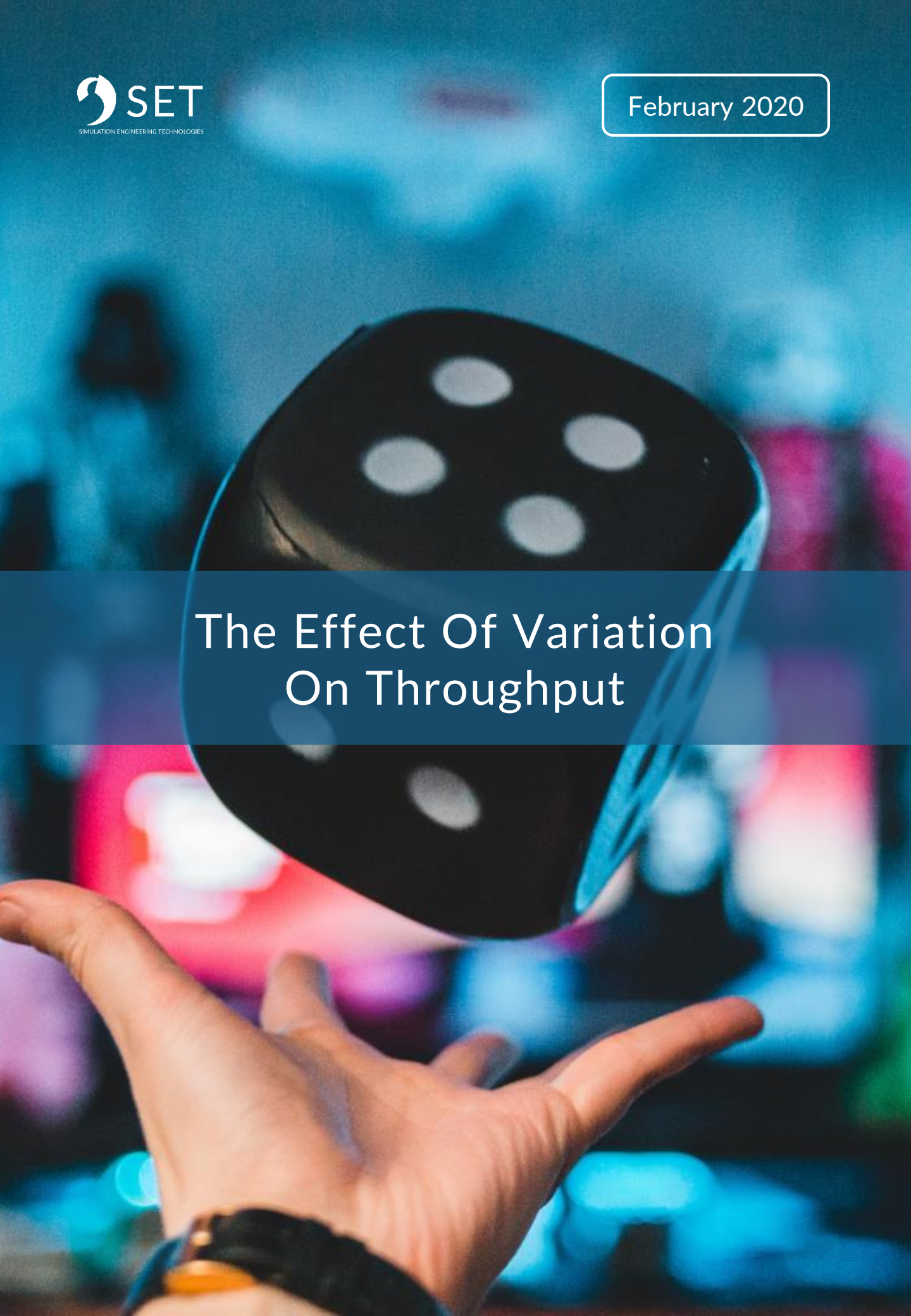
SET
SIMULATION ENGINEERING TECHNOLOGIES

February 2020

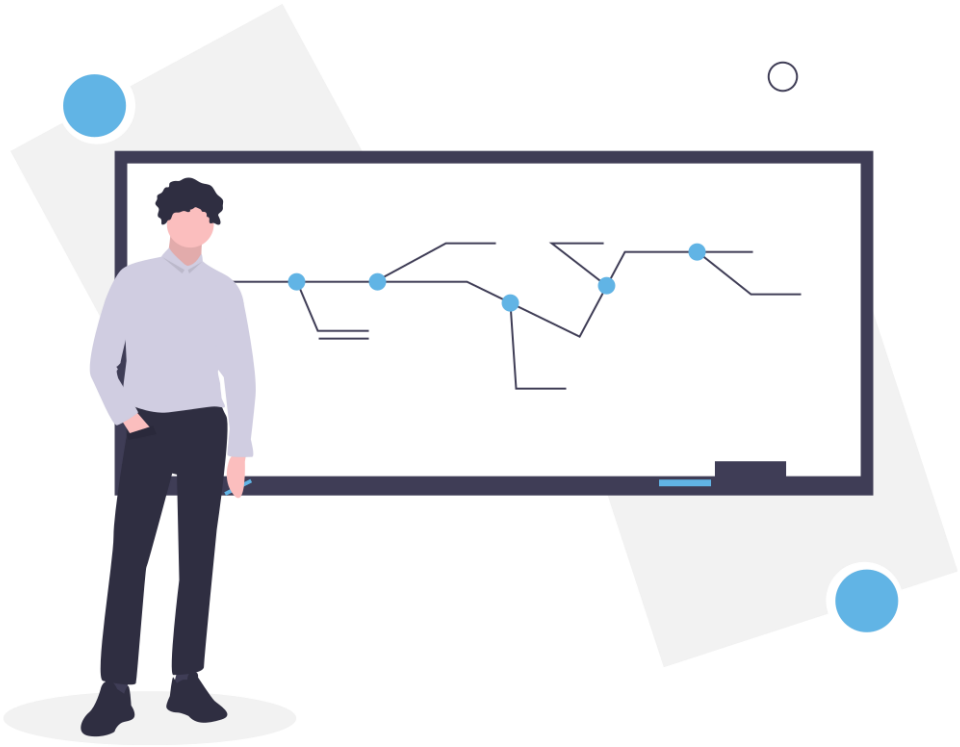


The Effect Of Variation On Throughput

What is Variation?

Variation is the degree of the difference between an ideal and an actual situation. Variation in a system can result in budget overruns, late order deliveries, long queuing or waiting times, reduced throughput etc.

A simulation is a computer model that mimics the behaviour of a real system by representing operations of a real-world or planned system. The difference between a simulation and an everyday planning model, is that the simulation accounts for variation.



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Variation Example

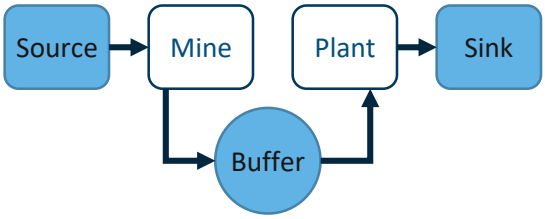
Consider the following example of a Mine feeding into a Plant. If both the Mine and Plant produce throughput at a constant rate of 1 000 tonnes/hour, the output of the system will be 1 000 tonnes/hour.

In reality, there is some variation in the processing capabilities of these entities. If the Mine is processing at a constant rate of 1 000 tonnes/hour, and the Plant is processing at a varying rate which is sometimes slower than that of the Mine, the total throughput will be slower.

In addition, if the Plant is processing at a faster rate than the Mine, the total throughput cannot increase to higher than 1 000 tonnes/hour. Therefore, the throughput will always be lower than the deterministic model due to the presence of variation.

One way in which the effects of variation is often mitigated in real-world scenarios is by placing a buffer between two processes.

For demonstration purposes, a buffer is also added to the simulation. By increasing the buffer capacity, overall throughput can be increased. This unfortunately only holds true up to a point after which the increased buffer capacity has a negligible effect.



Ideally, the variation can be captured through historic data which can be used as distribution inputs for the simulation model to produce accurate results.

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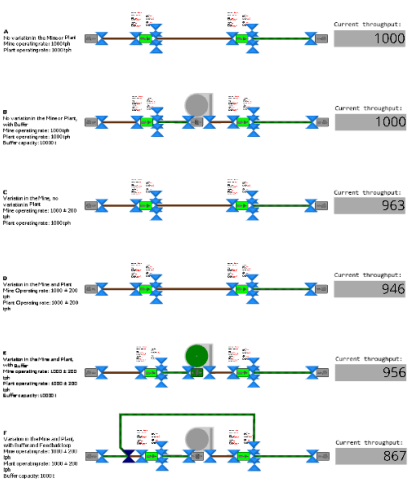
Using the Model

The Model contains six instances (A-F) of the set-up described above with a description of each on the left. The throughput rate is measured on the right.

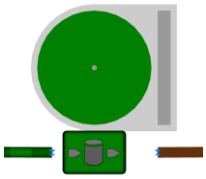
The deterministic model (A) delivers a throughput rate of 1000 tonnes/hour. This result is the same even when a buffer is added (B).

Since the processing rate of the Mine and Plant are matched exactly, the buffer never fills. Instance C shows the Mine operating at a varying rate and in instance D where both the Mine and Plant has variation in processing rate, the throughput is the lowest.

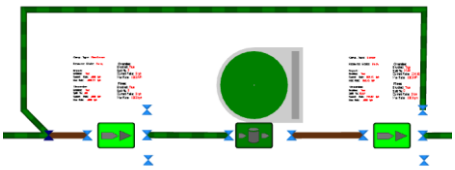


Simulation Model of the Effect of Variation.

By adding a buffer (E) as shown below, the throughput can be improved again as it somewhat mitigates the effect of variation.



Instance F, shown below, demonstrates the effect that a feedback loop can have when variance is present.



Essentially, a large portion of the material has to pass twice through the Mine and the Plant, thereby compounding the effect of the variation.

If you would like download the model, click here. Take note that you will need to use Simio™ in order to run the model. Click here to download a trial version.

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Using the experimental model

The Experimental Model depicts a single instance of the set-up as described in instance E.

An experimental set-up, under **Scenarios**, allows for the quick evaluation of the full effect of variation. The *larger* the variation, the *lower* the throughput.

To demonstrate the relative effect of the buffer, varying buffer capacities are also tested (see below).

Essentially, the effect of variance can be mitigated through a buffer, but the main aim should be to reduce variance as far as possible.

The results of the various scenarios can be visually compared under the **Response Results** tab.

The first seven scenarios demonstrate the effect that variation has on the throughput and next seven show the effect of an increasing buffer size.

Scenario			Replications		Controls			Responses
☑	Name	Status	Required	Completed	Mining Rate (Metric Tons per Hour)	Plant Rate (Metric Tons per Hour)	Buffer Capacity (Metric Tons)	AverageThroughput ...
☑	Scenario1	Idle	10	10 of 10	1000	1000	1000	1000
☑	Scenario2	Idle	10	10 of 10	Random.Normal(1000,200)	1000	1000	919.925
☑	Scenario3	Idle	10	10 of 10	1000	Random.Normal(1000,200)	1000	919.925
☑	Scenario4	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	1000	904.774
☑	Scenario5	Idle	10	10 of 10	Random.Normal(1000,150)	Random.Normal(1000,150)	1000	928.581
☑	Scenario6	Idle	10	10 of 10	Random.Normal(1000,100)	Random.Normal(1000,100)	1000	952.387
☑	Scenario7	Idle	10	10 of 10	Random.Normal(1000,50)	Random.Normal(1000,50)	1000	976.194
☑	Scenario8	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	0	868.708
☑	Scenario9	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	500	901.26
☑	Scenario10	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	1000	904.774
☑	Scenario11	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	1500	904.774
☑	Scenario12	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	2000	904.774
☑	Scenario13	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	2500	904.774
☑	Scenario14	Idle	10	10 of 10	Random.Normal(1000,200)	Random.Normal(1000,200)	3000	904.774

Various scenarios that you can edit and test in the **demo model**.

Download the demo model

SET specialises in various mining models. To find out about other models, including case studies and use cases, please contact us today.

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About SET

Simulation Engineering Technologies (Pty) Ltd (SET), now part of 4Sight Holdings Ltd., is a consulting company and a leader specialising in creating accurate, discrete-event computer simulation models.

The company's mission is to increase a company's outputs with optimal process change decisions that are made with a high sense of certainty and trust.

SET's business model enables its clients to make intelligent decisions that will help reduce capital spend while increasing required throughputs.

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