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# ***GOLDEN PRODUCTION APPROACH NOTE***

# PREFER A VIDEO TO SLIDES?

**Golden Production Run App:**  
Achieve consistent Production for  
your campaigns/ batches



Here it is: YouTube

<https://youtu.be/kfJRAO6a2KA>

# THE NEED FOR A NEW APPROACH TO GOLDEN BATCH



The R&D Golden batch does not consider process variabilities for e.g., raw material variations, asset performance deterioration, ambient conditions, etc.



Multi-step and often complex processes require multi-variable analysis over long and variable batch cycle times (BCT). This evaluation is a difficult one and requires significant manual effort.



Most of this analysis is offline and dated and may not be most relevant to current production runs.



In terms of alerts and recommendations, real-time guidance is not given to operators.



Subject Matter Experts understand areas where processes deviate, but in terms of variations in parameters that cause them, they are not sure of the exact root cause.



*“I already have a Golden Batch, why do I need another one?”*

# IMPACT OF INADEQUACIES IN CURRENT APPROACH

- Complex Interactions between Processes
- Raw Material Variabilities
- Long batch Timing

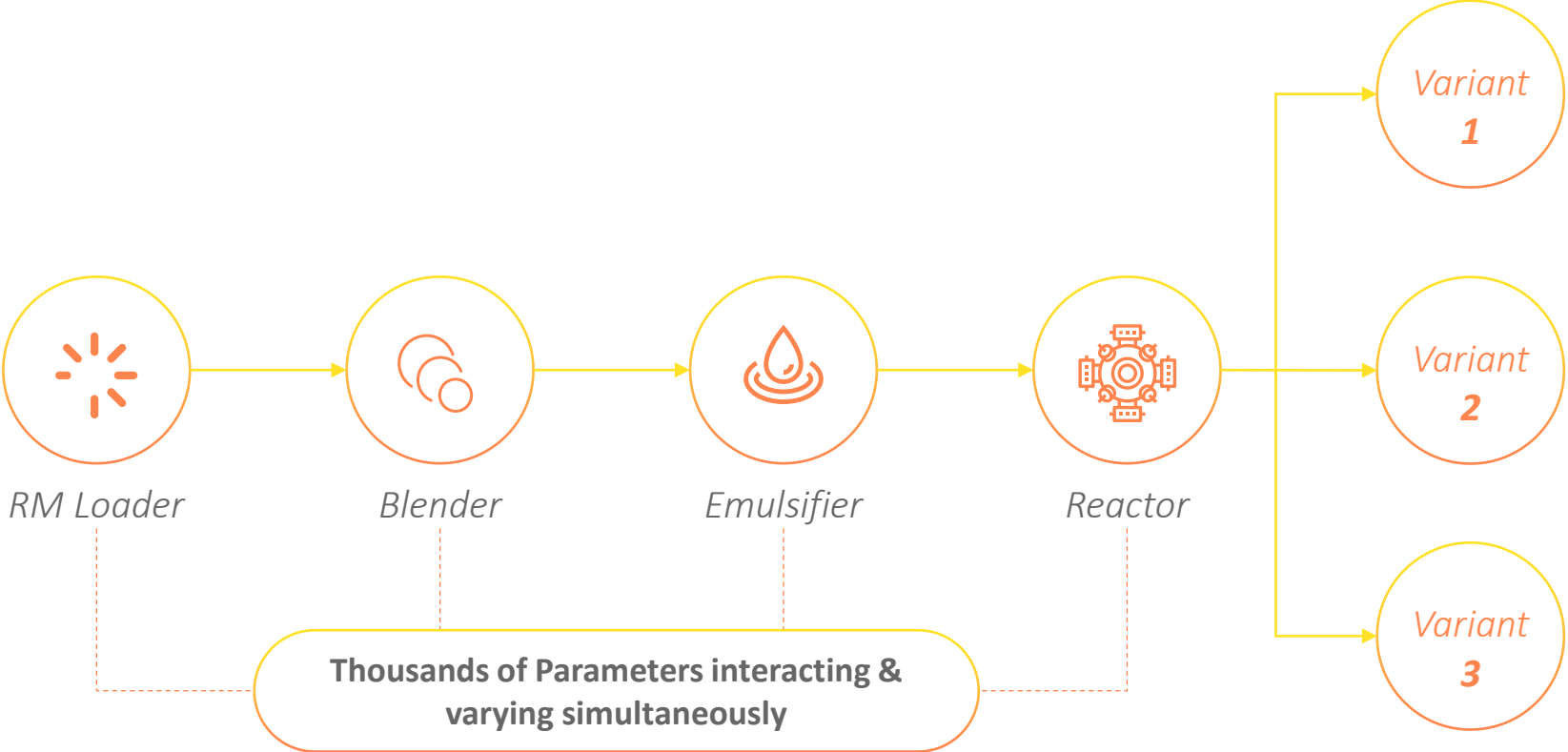


Fig: Illustrative Chemical Process

- Fluctuating Yield across batches
- Sub optimal Production
- Quality Issues
- Rejected batches



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# ***OUR GOLDEN PRODUCTION SOLUTION***

# HOW DO WE GET TO GOLDEN PRODUCTION



## FEATURE GENERATION

- › Feature Engineering by consideration of long BCT (Batch Cycle Time)
- › Integration of a) Compositions b) In-Process Parameters c) Yield d) Production Quantity e) Quality Results f) Asset Down times and Maintenance
- › Algorithmic quality checks to ensure we process good and relevant data
- › *We handle the complexities arising out of Time dimensions and complex process interactions in terms of data preparation*



## IDENTIFY THE GOLDEN THREAD

- › Statistical Pattern Identification and correlations between varying parameters with the output produced For e.g., identifying the of variation of parameters such as pH of product, ammonia volume, adjusting ph to make, oxygen, temperature etc. with the yield of the anti-biotic



## GENERATE PARAMETER SCORECARDS

- › Identification of Prime Contributors of Variations in output metrics



## VALIDATE THE GOLDEN THREAD

- › Validation with Domain Experts and Model fine-tuning

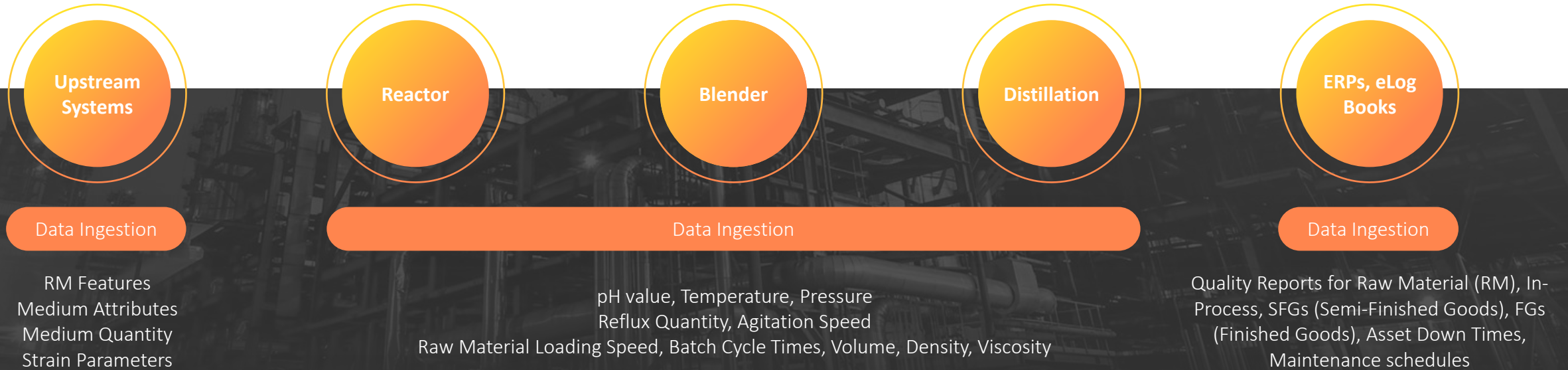


## ENJOY THE GOLDEN PRODUCTION

- › Get Consistent Production Runs from your processes

# STEP 1.1 – GENERATE FEATURES (PROCESS VIEW)

Illustrative process

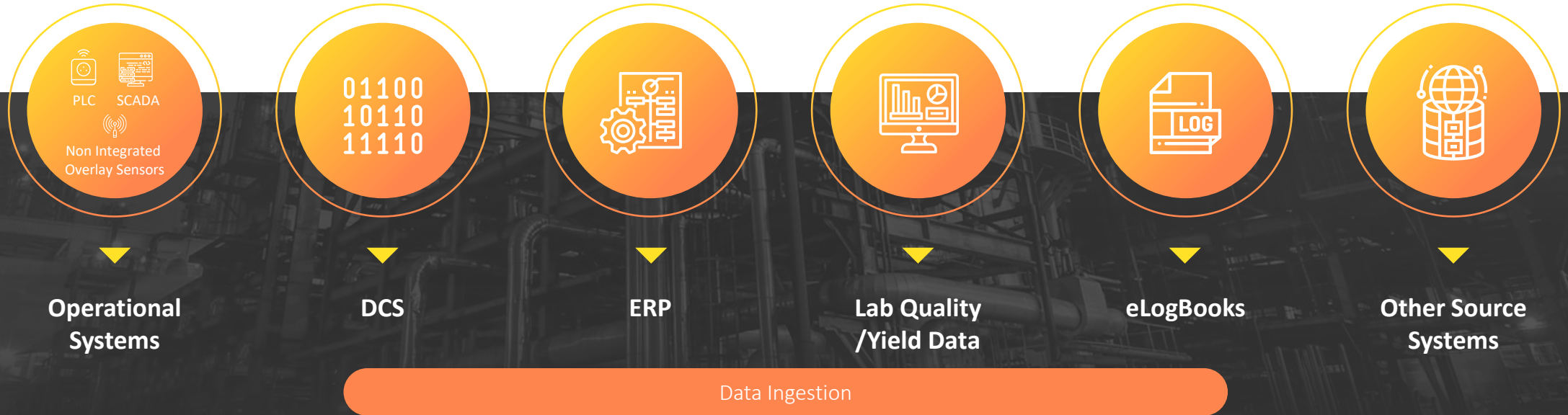


Feature Generation Process

Automated Data Quality Checks

Harmonized and Integrated Data

## STEP 1.2 – GENERATE FEATURES (SYSTEM VIEW)



Feature Generation Process

Automated Data Quality Checks

Harmonized and Integrated Data



# STEP 2 – IDENTIFY THE GOLDEN THREAD



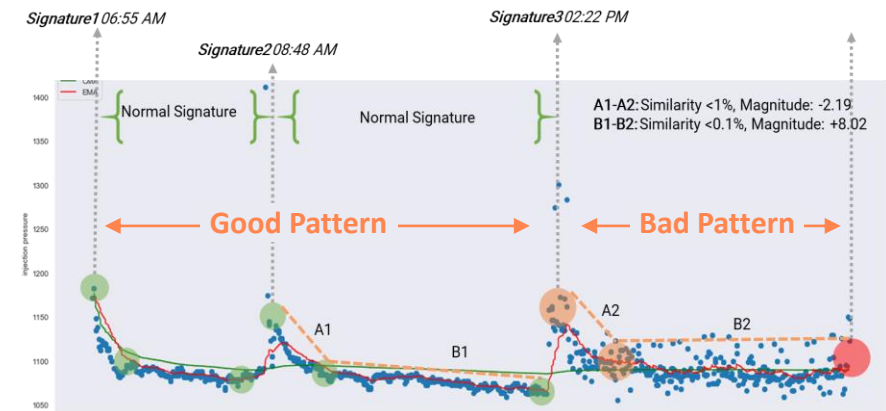
## STEP 1 INTEGRATED DATA

- › Setting up of goal in terms of Yield/Production/Quality
- › Identification of good signatures
- › Signature comparison (Generation of similarity scores)
- › Ranking of recurring patterns
- › Correlations with Parameters

PROCESS MEMORY BASED ALGORITHMS

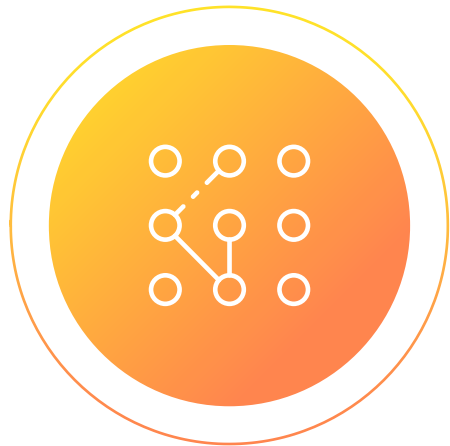
Combination of Compositions, Parameters contributing to bad batch

Example of a Pattern



Illustrative Non-Linear Pattern Signatures for Good and Bad Run

# STEP 3 – GENERATE PARAMETER SCORECARDS



## STEP 2 PATTERNS

- › Identify the combination of maximum impact parameters in terms of significance scores and magnitude of variations when the output of the run is not up to the mark.

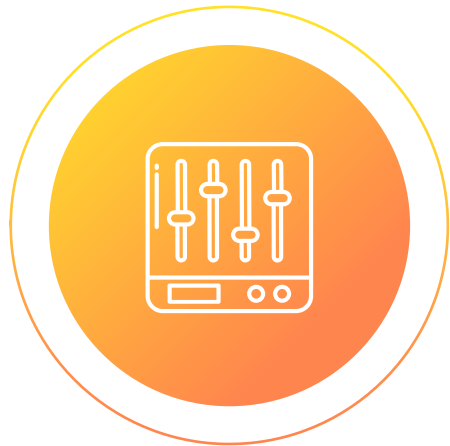
List of Parameters and their impact on the output

Example of a Significant scores

Feature	Significance
swov_a_hyd_prs_x_x_act	78.00%
brl_a_zn_06_tmp_x_x_act	75.43%
<b>switchover_prs_diff (derived)</b>	72.09%
brl_a_zn_05_tmp_x_x_act	71.94%
brl_a_zn_04_tmp_x_x_act	57.13%
brl_a_zn_03_tmp_x_x_act	49.27%
injection_prs_diff	41.53%
brl_a_zn_02_tmp_x_x_act	34.72%
clo_x_tim_x_x_act	27.08%
inj_a_x_prs_max_x_x_act	26.77%
csh_a_x_str_x_x_act	12.44%

*e.g. Identification of Contributors and scores*

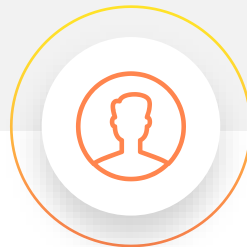
# STEP 4 – VALIDATING THE GOLDEN THREAD



## STEP 3 PARAMETERS



- › Validation with Subject Matter Experts on Parameter relevance and associated importance with output Metrics



Complimenting the Subject Matter Experts with the Data

Golden  
Production  
Parameters

For e.g.

Feature	Significance	
swov_a_hyd_prs_x_x_act	78.00%	👍
brl_a_zn_06_tmp_x_x_act	75.43%	👍
<b>switchover_prs_diff (derived)</b>	72.09%	
brl_a_zn_05_tmp_x_x_act	71.94%	✖
brl_a_zn_04_tmp_x_x_act	57.13%	👍
brl_a_zn_03_tmp_x_x_act	49.27%	✖
injection_prs_diff	41.53%	👍
brl_a_zn_02_tmp_x_x_act	34.72%	✖
clo_x_tim_x_x_act	27.08%	👍
inj_a_x_prs_max_x_act	26.77%	✖
csh_a_x_str_x_x_act	12.44%	👍

# STEP 5 – ENJOY GOLDEN PRODUCTION ...EVERY TIME!

Golden Run  
Every Time



Real Time Guidance  
System for Operators



Alerts for Production  
Leadership Teams



Consistent Quality  
Outcomes

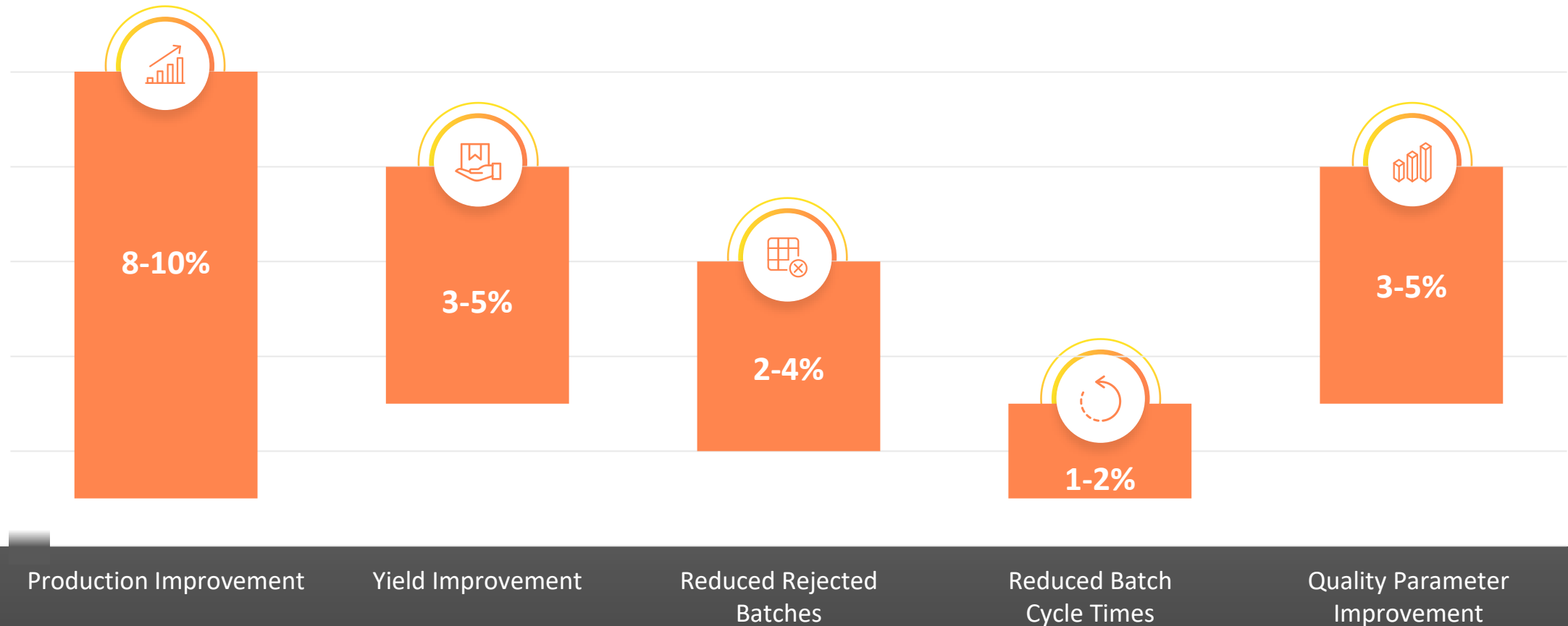


Online Available  
System

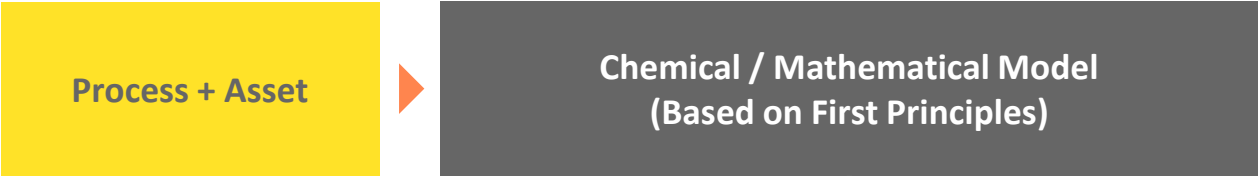


Simulations

# WHAT IS GOLDEN PRODUCTION ROI

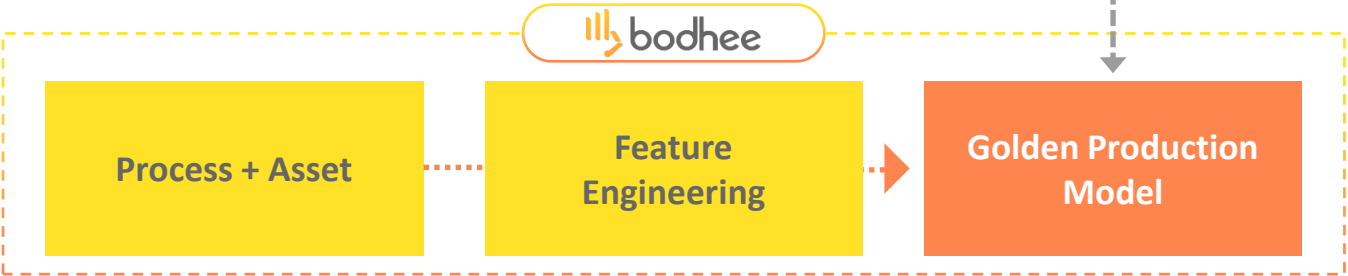
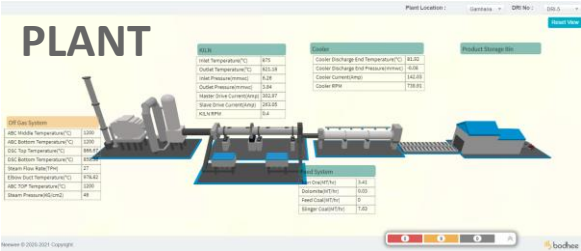


# HOW DOES IT COMPLEMENT CHEMISTRY MODELS



### Characteristics of Chemical Model

- › Based on principles of Chemistry and complimented by Thermodynamics principles
- › Simplify complex situations
- › R&D Golden Batches are generally based on these models



### Characteristics of Golden Production Model

- › Works on real time and Actual production data
- › Time Dimension ( Batch Cycle Time) considered during the analysis
- › Multilayered – Accommodates process complexities
- › Considers various system variabilities like wear and tear
- › Can integrate output of various Engineering / Mathematical Model

# HOW WE SCORE OVER STATISTICAL SOFTWARE AND EXCEL MACROS?

	Statistical Software/ Excel Macros	Golden Production Solution
 <b>Build Vs. Ready-made</b>	Do-It-Yourself model with burden on the customer to get the required <b>resources and time</b> to build the statistical Models	Ready made Model specifically designed to have consistent Golden Production every Time
 <b>Connecting Processes</b>	Connecting Processes is a technically challenging task and requires significant technical expertise as well as effort	Enabled by default
 <b>Single Step Vs. Multi-Step Models</b>	Majority of the models which are available are suitable for a <b>single-step approach</b> and cannot be used for Process twins as is	Easy Single and Multi-steps model configuration based on the use case
 <b>Scaling</b>	Scaling is a challenge as we need to rebuild it for each process taking time	Easy Process Modeling for the new process with one-click reusability
 <b>Feature Generations</b>	Feature generation modules must be built	Ready Made Process/Batch centric feature generation library for easy reuse and configuration

# WHAT IS OUR DIFFERENTIATION

Specialized Algorithm specific for Golden batch



Ability to handle Variabilities creeping in Run time



Impact on the outcomes in 6-8 Weeks



Run Time guidance to operators on parameters settings to produce optimal outcomes



End to end solution — Hardware Integration to golden batch actionable



# WHAT IS THE END STATE

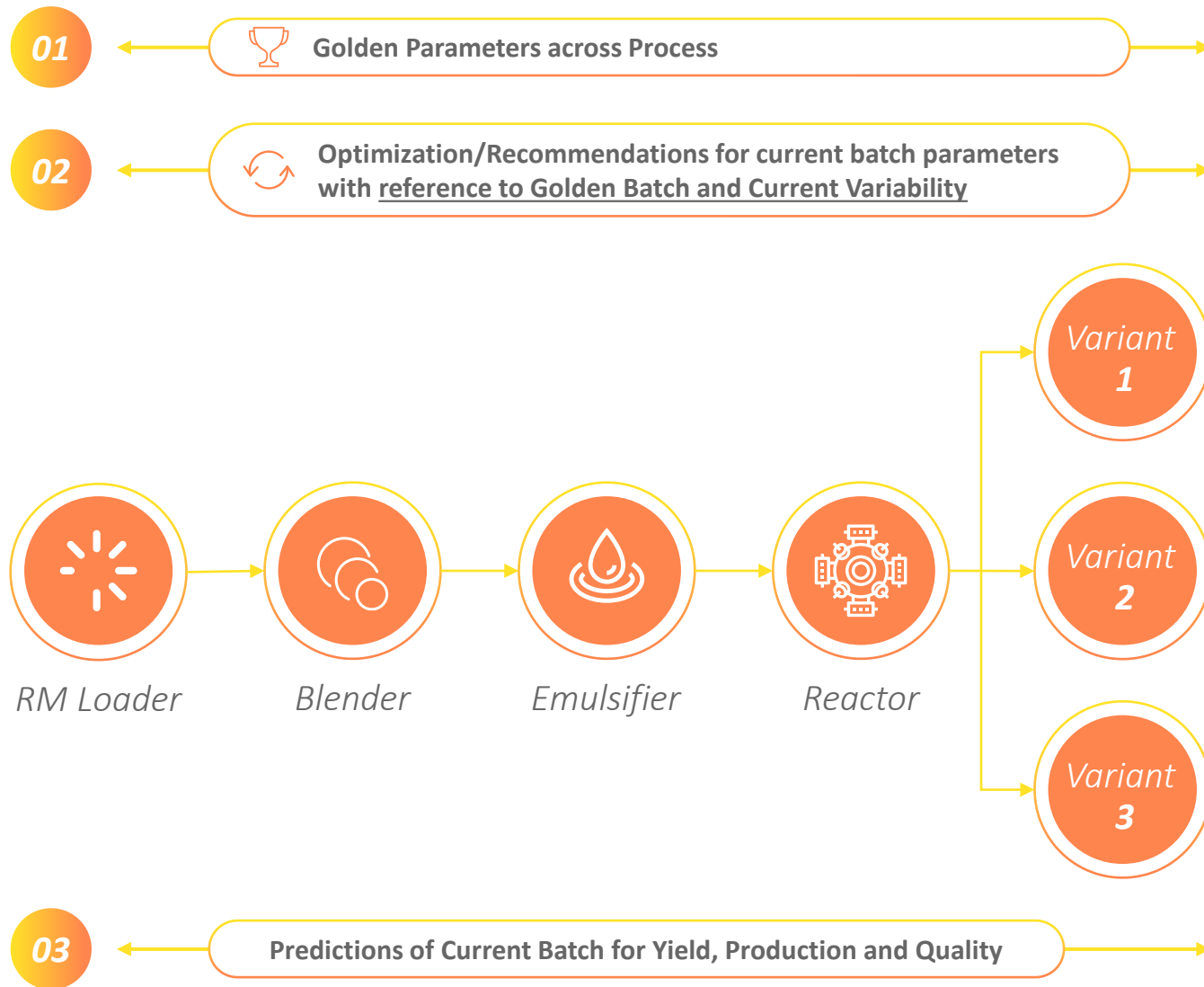


Fig: Illustrative Chemical Process

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# *THANK YOU*

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