



# The CMAC Digital Twin

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## Digital Twin

- The **CMAC Digital Twin** for medicines development and manufacture incorporates the **data, models** and **knowledge** that describe the **materials, products, and processes** delivering the required product attributes.
- The **CMAC Digital Twin** system is built on a foundation of data, both experimental and simulated.
- Knowledge gathered within **CMAC DataFactories**, driven by **QbDD workflows**, populates the **Digital Twin** databases. These structured data enable process design and control strategy development resulting in transfer to right first time operation in **MicroFactory** test beds.

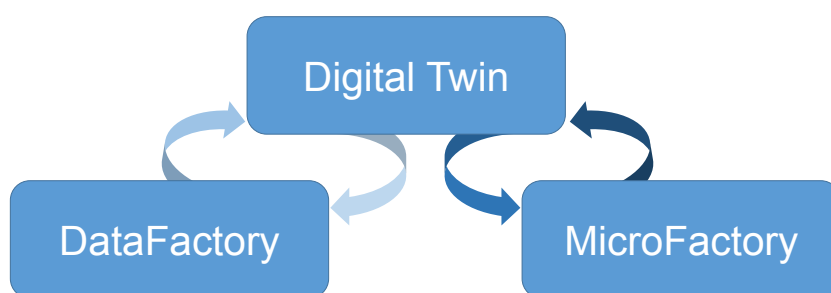


Figure 2: High level representation of how the Digital Twin sits on top of both the DataFactory and the MicroFactory. The Digital Twin requests data from the DataFactory which is then extracted, transformed and loaded (ETL) into Digital Twin databases. These data are then used to help optimise the digital design of the process and in turn operation in MicroFactory testbeds. MicroFactory data are then returned to the Digital Twin to increase the CMAC knowledge base.

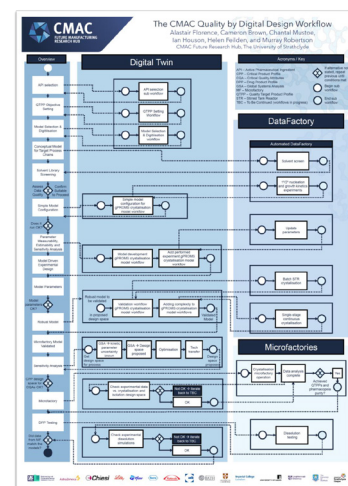


Figure 1: The CMAC Quality by Digital Design (QbDD) Workflow

## Digital Twin App

- A mobile phone and tablet-based application has been prototyped
- Allows quick and easy exploration of MicroFactory test bed data.
- Currently using pre calculated global system analysis (GSA) data from the mefenamic acid project
  - Future plans to incorporate additional modelling data, laboratory data and data from other projects
- User can adjust key parameters and instantly visualise how this effects property attributes and product performance.



Figure 3: Screenshots of the Digital Twin App. The home screen and a view of the four unit operations that make up the mefenamic acid microfactory.

Parameter	Options	Values
Mill Speed	3	3,000, 6,900, 23,000 rpm
Feed solution mass flow rate	3	5,10,15 g/min
Agitation rate (MSMPR vessels)	243 (3 values, 5 stages)	100, 300, 500 rpm
Temperature (MSMPR vessels)	35 (across vessels 2-4)	55, 50, 45, 40, 35, 30, 25 °C

Table 1: Variables within the GSA calculation. A total of 76,545 calculations. Total computational time, at roughly 10 minutes per calculation, is roughly 530 days.

## App Download

android

Download the Digital Twin App for Android

- Go to your Android Settings > Apps & Notifications.
- Select Advanced or the three dots at the top-right corner
- Select Special App Access.
- Choose Install Unknown Apps.

