

An Efficient and Straight Forward Inventory System at a Growing Drug Discovery CRO

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ABSTRACT

Within a growing drug discovery CRO (Contract Research Organization) of hundreds of scientists, including chemists, biologists, and DMPK scientists across multiple sites, a KISS (Keep It Simple and Straightforward) and centralized inventory system to manage information on tens of thousands of chemical containers, including location and status, is becoming increasingly important, so that scientists can easily find necessary chemicals. In the meantime, scientists would like to conveniently update the location or status of a chemical container while moving or trashing chemical containers. In this article, we will describe an innovative facility, namely, the ScanStation, that has been implemented at Sygnature Discovery Ltd. in order to meet these requirements.

Keywords: Centralized chemical inventory management • KISS (Keep It Simple and Straightforward) system
• ScanStation

INTRODUCTION

At Sygnature Discovery, we started to implement a new chemical inventory platform in 2016. After thorough investigations, the ChemInventory platform[1] was selected to manage our common chemical reagent containers[2]. This platform is cloud-based and has an intuitive and user-friendly web interface. It runs on any web browser on our lab computers, and works well for chemical inventory management. However, in order to accommodate the rapid

growth of the organization which now has hundreds of scientists across multiple sites, an improved and centralized infrastructure was needed to tackle routine chemical handling jobs, such as moving or trashing chemical containers.

Articles and books are available regarding lab inventory management systems[3, 4], and also inventory management in the pharmaceutical supply chain[5, 6]. However, to the authors' awareness, a system that can centralize and simplify inventory management while remaining suitable for the drug discovery workflow has not been described in detail before. Following the KISS (Keep It Simple and Straightforward) principle, Sygnature Discovery and Chemical Inventory have collaborated to create a solution: ScanStation. It utilises smart technology, a Bluetooth

barcode scanner, an automated barcode label generation procedure and cloud technology to establish a centralized chemical handling facility.

In this article, first we will describe the lifecycle of a chemical reagent at Sygnature Discovery[2]. Then the computer usage of ChemInventory platform will be briefly described. In order to tackle the challenges of using computers for common chemical reagent management, the implementation of ScanStation will be described in detail subsequently.

The life cycle of a chemical reagent at Sygnature

As illustrated in the workflow shown in Fig. 1, scientists order chemical reagents through the Amici cloud-based portal[7]. Once chemicals containers arrive, they are collected and barcoded by the lab support team then delivered to individual scientists. Information collected during the ordering process can be used to register reagent containers in the ChemInventory platform. This delivery and registration procedure is carried out on a daily basis, and has been running smoothly ever since the ChemInventory was implemented at the company. Scientists will then use the reagents for their experiments, including

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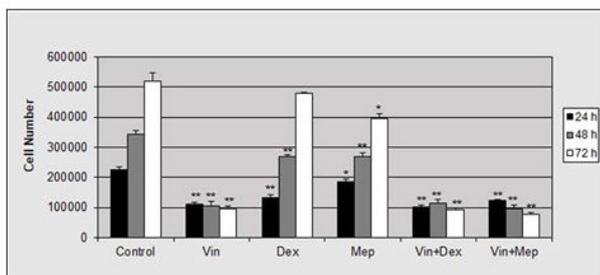
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compound synthesis. They may obtain the chemical containers from a common reagent storage, or from other scientists, and return them once they have been used. Each chemical container movement should be accompanied by a status update within the ChemInventory, made by the individual scientist. This will ensure that the location or status of a chemical container can be accurately tracked and monitored. Once it is empty or no longer required, a chemical container will be trashed or otherwise disposed of, and the record will be updated within the ChemInventory accordingly.

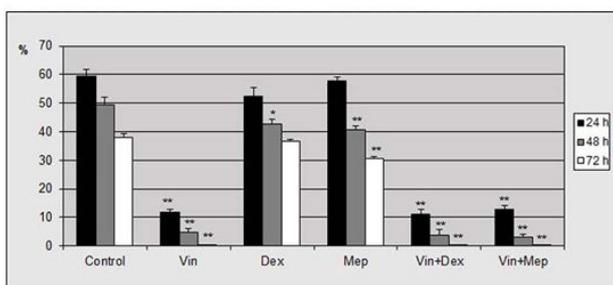
Fig. 1: The life cycle of a chemical reagent at Sygnature. The main aim is to simplify scientists' routine jobs.



Using the ChemInventory in a web browser

More details on using the web interface of the ChemInventory system can be found on the ChemInventory website[1]. Within the web interface shown in Fig. 2, lab technicians can register chemicals, and informaticians can administer the platform. Scientists are able to search for chemicals via name, synonym, substructure or CAS (Chemical Abstracts Service) number, and determine its location. They can also update the records when moving or trashing chemical containers.

Fig. 2: Computer web interface of the ChemInventory platform. The icon of 'internal tutorials' will lead to company's Microsoft SharePoint informatics section.



The location hierarchy with Sygnature ChemInventory is illustrated in Fig. 3. The top level are buildings across multiple sites. Under each building, we have two types of locations. The first type is store locations, and under the store locations, there are rooms, shelf, boxes, etc. The second type is user location which corresponds to individual scientists.

The web interface worked well to meet our demands when it was first implemented. However, with the rapid growth of the company, it is becoming increasingly important that we have a simple, centralized inventory platform to manage tens of

thousands chemical containers. Our scientists recognised a number of drawbacks with the system:

While moving or trashing chemical containers, an immediately-available computer is not always guaranteed, if they are all being used for other purposes, such as writing research reports etc.

The process of logging on to the computer and then onto the ChemInventory platform takes time, delaying the process.

Computers are not available inside the store room.

In order to tackle these concerns, we started to look at how we might improve our inventory management infrastructure. We wanted to add the following features:

The system should be on all the time, and always available in each lab and store room.

It needed to be very simple and intuitive to use. Chemists should be able to update a chemical container's location and status within a few seconds.

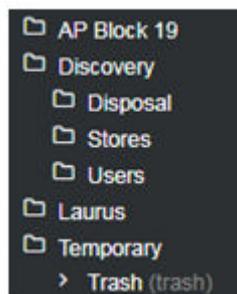
It should require only minimal system support.

The system should be centralized, and the installation should be standardized.

It should be possible to extend the system to the inventory management of other items, including equipment and consumables to improve overall laboratory management.

The costs should be controllable so that the system can be economically scaled up with further installations as the company grows. While it would be possible to purchase and install further computers, this would incur significant costs and require more resources for maintenance. As a more practical alternative, in collaboration with Chemical Inventory company we have developed the centralized chemical handling facility we call ScanStation.

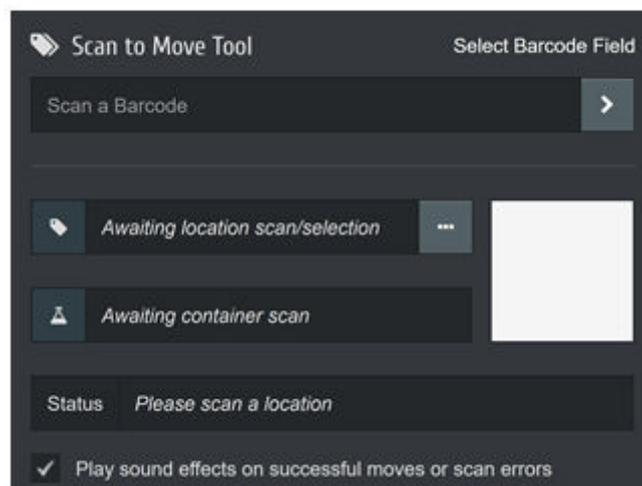
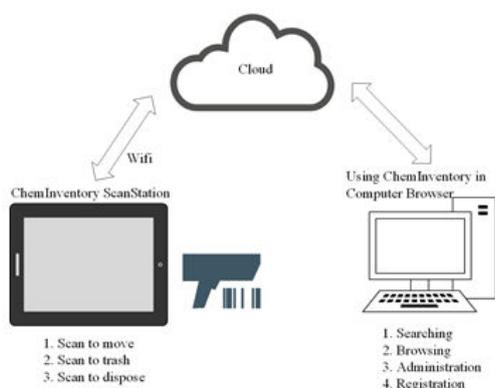
Fig. 3: Location hierarchy within ChemInventory for Sygnature scientists.



The ScanStation facility

The ScanStation facility consists of a number of key components, including tablets, the tablet operating system, a software interface, and Bluetooth barcode scanners. In order to make ScanStation work seamlessly, various types of barcodes have been designed, and the barcode generation procedure has been automated.

Fig. 4: Inventory management system at Sygnature Discovery Ltd. ScanStation is used for routine jobs, while the computer web interface can be used for all purposes.



Tablet under Microsoft Windows Kiosk mode

A tablet computer running Microsoft Windows 10 Pro was chosen, and this will be routinely maintained and upgraded. In order to make the tablet user-friendly, Windows Kiosk mode was selected for the ScanStation, with the tablet interface configured so that it can only be used for ChemInventory. When in Kiosk mode, if scientists need to restart the tablet, there is no requirement to log in again, as the tablet automatically loads the ChemInventory interface.

The scan-to-move interface

The software interface – the scan-to-move process shown in Fig. 5 – is simple and informative. Scientists first scan the barcode of the destination location, and then scan the chemicals one at a time. This will move all scanned chemicals to the specified location. Should an error occur, the status field will be highlighted in red. Different sound alerts are used to indicate successful scanning as well as errors. The user can reset the location field manually by pressing the left icon of the location field, as shown in Fig. 5. The scan-to-move interface also incorporates several special scenarios. For example, scientists have the option to choose the location manually instead of scanning. Should the barcode on a bottle be unclear, they can type the barcode number instead to obtain its information. The interface automatically refreshes after two minutes of inactivity, resetting the location and status fields.

Fig. 5: Scan-to-move interface. From top to bottom, the fields are barcode, location, chemical reagent and status. The location field resets after two minutes of inactivity, and it can be reset manually by pressing its left icon. Location can also be chosen by pressing the field's right icon. The status field indicates either successful scan or error, accompanied by different sound alerts. The middle blank area will display corresponding chemical structure following a successful scan.

Location barcodes and generation procedure

Two types of barcodes are required, as indicated by the location hierarchy shown in Fig. 3. In order to make the ScanStation work smoothly, user-friendly barcodes were designed. These follow standard code128 format[8]. The user location barcode is the scientist's employee number, as shown in Fig. 6a. These are unique identifiers, and a barcode sticker can be affixed to their individual employee ids. Instead of scanning, they can also type in their employee number to retrieve the user location within the scan-to-move interface.

Fig. 6: Location barcode types and their usage.

(A). User location barcode, the number is the employee number.



These are unique identifiers, and a barcode sticker can be affixed to their individual employee ids. Instead of scanning, they can also type in their employee number to retrieve the user location within the scan-to-move interface.

The store location barcode is prefixed with S followed by a six digit number, as shown in Fig. 6c.

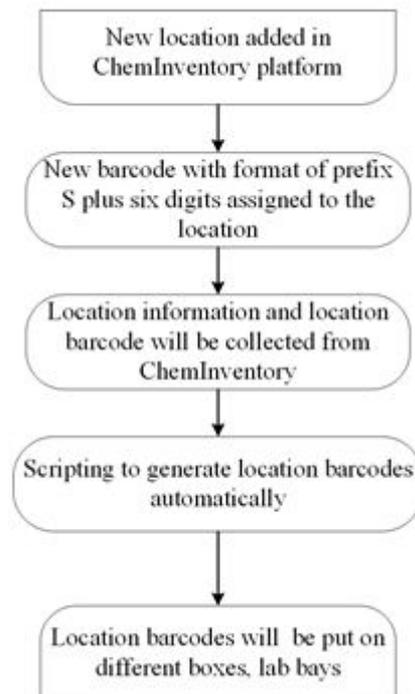
(c) Store location barcode. A Sygnature logo has been added on the left to distinguish it from other barcodes. At the bottom is the barcode number registered to the ChemInventory platform. On the right-hand side is the location name.



media/image7.PNG

In order to distinguish it from other barcodes, a Sygnature logo is next to it. Each box in every location is also barcoded, as illustrated in Fig. 6d.

(D)Store location barcode usage. Each box has been barcoded



Barcodes that include location information can be obtained from the ChemInventory platform, and a script was written to generate these barcodes, as illustrated in Fig. 6b. This allows us to generate new barcodes as they are required in a rapid and systematic way.

A disposal barcode, shown in Fig. 6e, is affixed near each ScanStation for scientists to scan when an empty bottle is placed in a disposal box. These disposal boxes are regularly collected by our waste disposal contractor.

(b)User location barcode usage. The barcode can be put on the swipe card.

(e)Disposal barcode format



There is already a significant number of location barcodes and, as the company continues to grow, increasingly more will be needed. We therefore formalised a systematic and sustainable method to automate the generation of barcode stickers, as illustrated in Fig. 7.

Fig. 7: Automated store location barcode sticker generation procedure.

The scan-to-trash functionality

Trashing is another common operation, carried out by scientists as they empty bottles of chemicals. The scan-to-trash procedure is analogous to the scan-to-move procedure. To achieve this, a trash location was created, as shown in Fig. 3, with its barcode given the name 'trash'. This trash barcode is placed close to each ScanStation, as shown in Fig. 8

Scientists first scan the trash barcode and then scan the chemical containers, after which they can be disposed of. The trash location differs from all of the other locations, as all the chemical containers scanned to that location will be deleted overnight. If a chemical container is trashed by accident, it can be recovered by scanning the correct location, as long as this is done the same day.

Fig. 8: Trash barcode and its usage.

(a) Trash barcode format.



(b) Barcode holders near a ScanStation. The left-hand side is for the trash barcode, and the right-hand side is for the lab locations



The ScanStation installation

A Bluetooth barcode scanner was selected for ScanStation to avoid a cable connection with the tablet, and make the scanner mobile. Each barcode scanner is paired with a single tablet, and this pair are labelled identically. Within the lab, the ScanStation works in a contactless mode. Scientists do not need to touch the scanner to scan the location, their user barcode or the chemical's barcode. Within the store, the scanner works in manual mode, and scientists can move the scanner to scan individual boxes or chemicals. The components and procedures for both the lab and the store have been standardized, and an instruction manual is available near each ScanStation.

Fig. 9: ScanStation layout at the lab and store.

(a) Lab installation. The Bluetooth barcode scanner works in contactless mode



(b) Store installation. The Bluetooth barcode scanner works in manual mode



ChemInventory ScanStation support

The ScanStation facility provides a simple way for scientists to carry out routine chemical inventory management tasks. For example, it reduces the process of moving or trashing chemical containers within the inventory from minutes to seconds. It also includes features that make the support procedure simpler. The tablet interface refreshes after two minutes, and will update automatically to install software upgrades. This minimizes the amount of manual support that is required. Each paired tablet and scanner have identical labels, and this used to track support tickets.

An 'internal tutorials' icon, as shown in Fig. 2, was included within the ChemInventory interface. This gives scientists easy access to the company's Microsoft SharePoint site with updated tutorials. A systematic training and demo procedure for informaticians, inventory champions and users has been formalized.

CONCLUSION

Through the joint effort of Sygnature Discovery and Chemical Inventory, we have implemented a centralized facility for scientists to manage the routine moving and trashing of chemical containers. Its benefits are summarized in Table 1.

Column1

Column2

Usability	Intuitive procedure. Scientists scan location barcode first, and then scan chemicals
Availability	always on, available in each lab and store
Supportability	Different types of barcodes have been highlighted using self-explanatory symbols. Each ScanStation is clearly labelled for support tickets. Updated instructions are easily accessible
Scalability	ScanStation components and installations have been standardized, barcode generation automated, and it is straightforward to install further ScanStations as the company grows

The implementation of ScanStation has greatly improved inventory management as the company grows. Initially, the

system was primarily used for chemical inventory management, but currently is being implemented across other departments along with general items tracking, such as equipment or consumables.

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