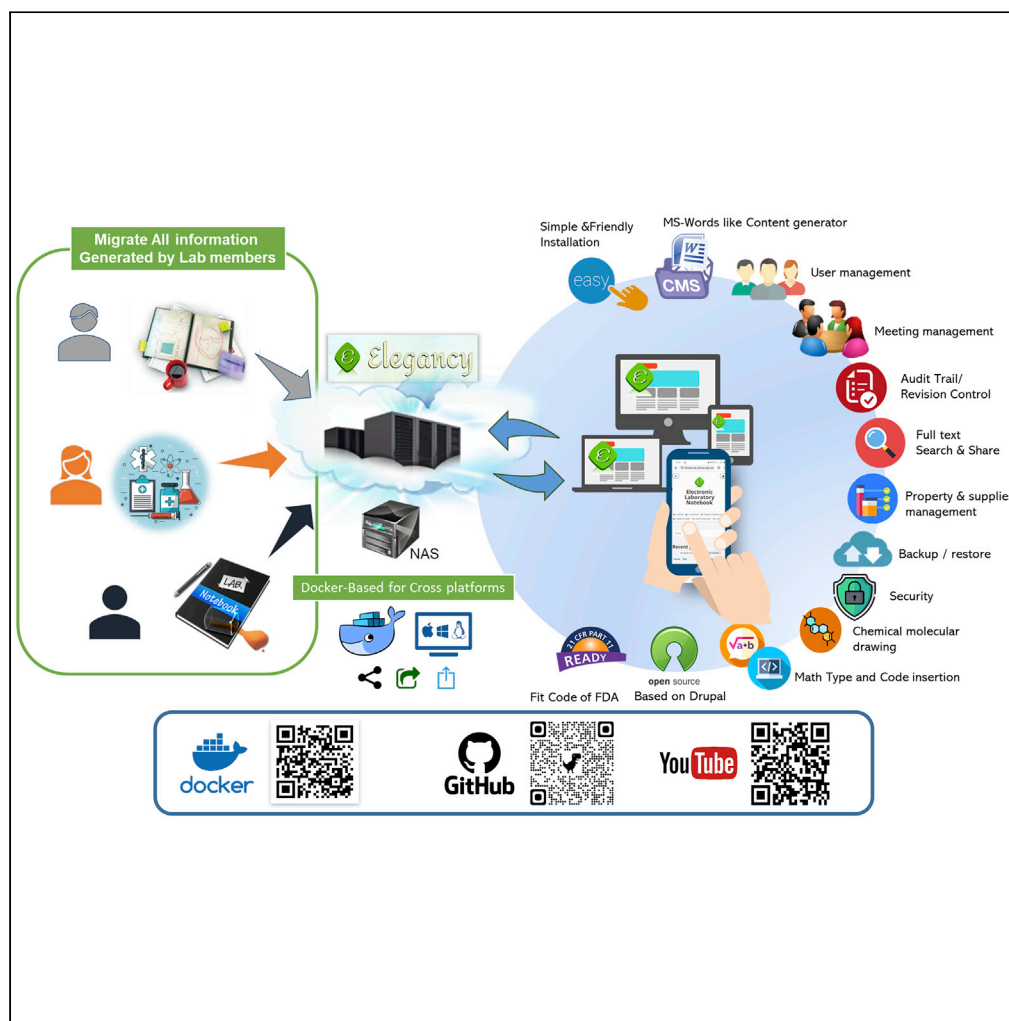


## Article

## Elegancy: Digitizing the wisdom from laboratories to the cloud with free no-code platform



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**Highlights**

An open-source module-based, charge-free no-code platform

Docker image ensures data backup and restoration

Biomedical laboratories are targeted but also suitable for all stripes

User authorization and audit trials guarantee data security

## Article

## Elegancy: Digitizing the wisdom from laboratories to the cloud with free no-code platform

Chih-Wei Huang,<sup>1,5,6</sup> Wei-Hsuan Chuang,<sup>1,5</sup> Chung-Yen Lin,<sup>1,3,4,6,\*</sup> and Shu-Hwa Chen<sup>2,\*</sup>

## SUMMARY

One of the top priorities in any laboratory is archiving experimental data in the most secure, efficient, and errorless way. It is especially important to those in chemical and biological research, for it is more likely to damage experiment records. In addition, the transmission of experiment results from paper to electronic devices is time-consuming and redundant. Therefore, we introduce an open-source no-code electronic laboratory notebook, Elegancy, a cloud-based/standalone web service distributed as a Docker image. Elegancy fits all laboratories but is specially equipped with several features benefitting biochemical laboratories. It can be accessed via various web browsers, allowing researchers to upload photos or audio recordings directly from their mobile devices. Elegancy also contains a meeting arrangement module, audit/revision control, and laboratory supply management system. We believe Elegancy could help the scientific research community gather evidence, share information, reorganize knowledge, and digitize laboratory works with greater ease and security.

## INTRODUCTION

Paper-based laboratory notebooks have long been the dominant platform for recording experimental data in the scientific community. However, data written on paper cannot easily be searched, shared, or backed up and can easily be misplaced or lost. As stated in one study, up to 17% of undigitized research data are lost yearly (Vines et al., 2014). In addition, with the increasingly automated and modernized lab equipment, massive volumes of data are generated in a digital rather than physical format. These issues have given rise to Electronic Laboratory Notebooks (ELN), single platforms capable of storing, organizing, searching, and sharing experimental data (Riley et al., 2017). ELNs significantly reduce human error in data archiving, making sharing information more convenient. Users can gain access to an ELN anytime and anywhere. Because ELNs can be saved locally or in the cloud, data are backed up multiple times. Many ELNs are in the market, each with its merits (Huchet, 2021). For example, SciNote (<https://www.scinote.net/>) is fairly intuitive and installed locally or through Docker containers.

Similarly, eLabFTW (Hewera et al., 2021) is open-source software that supports local and cloud hosting. eLabFTW also offers a Docker image. However, as with most commercial ELNs, they provide limited storage and only a few functions in their unpaid version.

Thus, we created a cloud-based ELN, Elegancy, which employs a hybrid system of Drupal and our developed modules. Users can install it on local machines or servers with no code at all, and they can access it using a web browser on any mobile device. It is open-source and easy to install and navigate, with all functions available in the same package. Most importantly, Elegancy is entirely free. Elegancy is suitable for laboratories of any type and limits users. Elegancy would, therefore, be of great use in information sharing and lab work management in the research community.

## RESULTS

Elegancy is built with a handful of powerful tools that fulfill the basic needs of all kinds of laboratories, as illustrated in Figure 1. Here, we introduce the main advantages of Elegancy:

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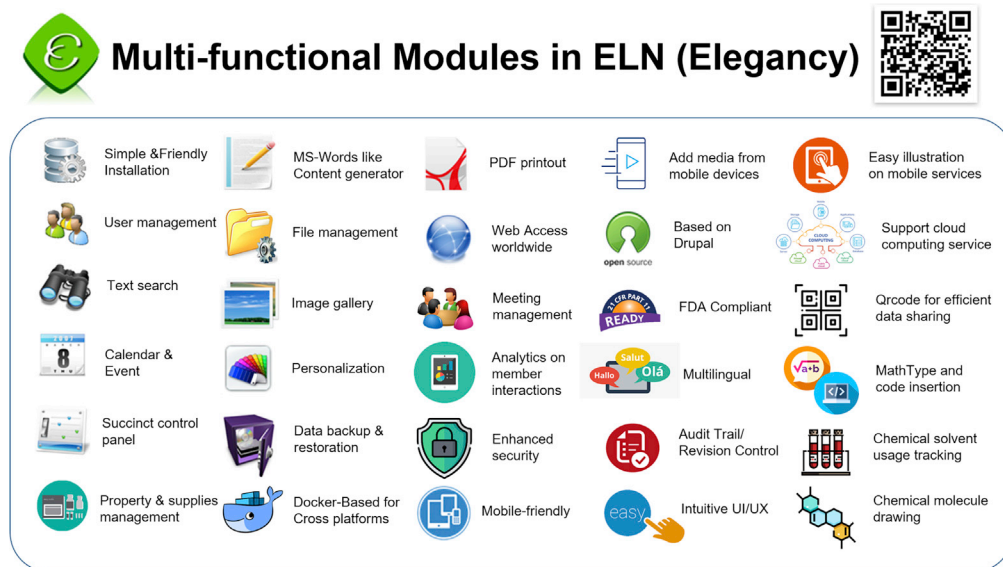
<sup>5</sup>These authors contributed equally

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**Figure 1. The multi-functional modules in elegancy**

An overview of Elegancy's main features. It is equipped with all the necessities an electronic notebook requires, from the basic functions such as text editor and file management to those specifically added for biomedical laboratories like chemical molecule drawing. Elegancy also guarantees data safety by following regulations on audit trials and providing data backup and restoration.

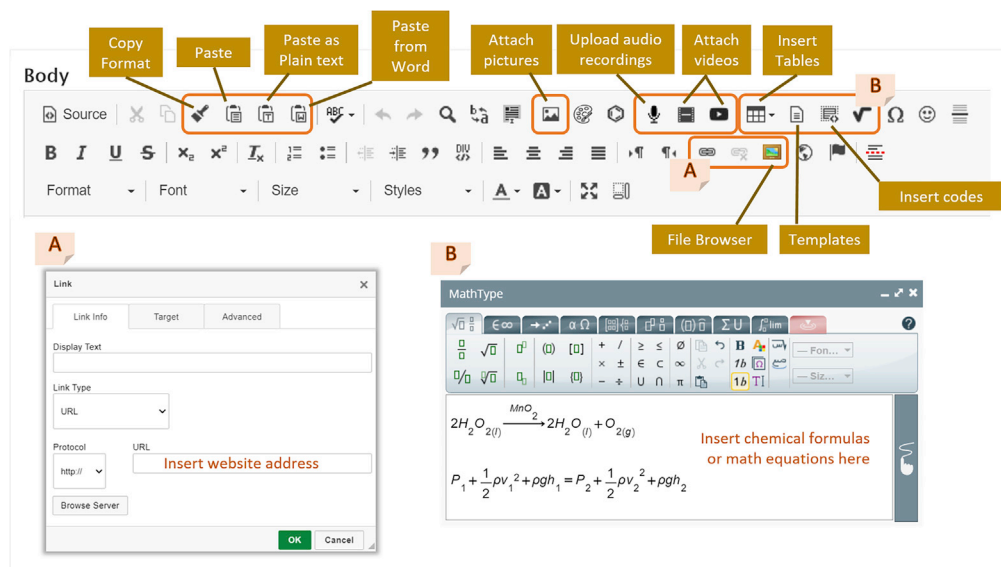
### Great user experience and practical facilities

Elegancy is easy to set up with no code. Users can build their ELN by following the simple instructions and tutorial videos provided on our website. The graphical user interface is intuitive and uncluttered. Options are displayed on the top of the panel, including a calendar that also serves as a timestamp. Users can also track the consumption of either office supplies or chemical solvents. English is the default language of Elegancy, with Mandarin and Japanese as built-in options. Users who have the resources for translation may add other languages. We provide multiple background themes for users to choose.

Regarding post-editing, the text editor is similar to commonly used software, such as Microsoft Word or Google Documents. Users can insert code, images, or tables and attach links to uploaded files, multimedia, or other posts (Figure 2). All forum posts can also be exported as PDFs, and their source code is open for template modification if necessary. Elegancy has further been developed to facilitate collaboration. Users can share posts and meeting invitations with other users through e-mail from our ELN. Elegancy also includes a module that analyzes the interactivity between members, which can be presented in charts. Figure 3 is an example of a forum post. Lab members can comment under the main text and reply directly to each comment, thus creating a thread of discussion related to the topic.

### An all-purpose notebook with special features aimed at biomedical laboratories

Although Elegancy fits all laboratories, these features are highly beneficial to experimental labs. We included Math-Type and Chem-Type plugins from CKEditor to create mathematical equations and chemical formulas. A module for drawing chemical structures is provided; users can also import chemical molecule JSON or CML files (Figure 4). What is more, we developed an optimized mobile device interface. Users can upload photos, drawings, or recordings to their ELNs directly from their phones, saving time and reducing human error in moving data from paper to computers (Figure 5). Elegancy also offers a platform for supply and property management. Although only site managers are granted the authority to create new inventories, all lab members can keep track of their property and supply usage by typing in information, i.e., property name, user, keeper, location, and purchased date (Figure 6). There is no limit on the number of inventories, and the entire supply and property record can



**Figure 2. Elegancy offers sufficient tools for content editing**

(A) Aside from the fundamental text editing tools, users can embed multimedia information such as audio recordings or video links.

(B) Users can even insert their codes, chemical formulas, or mathematics equations.

be exported as CSV files. In short, Elegancy can be used to document both dry and wet-lab investigations of any research project.

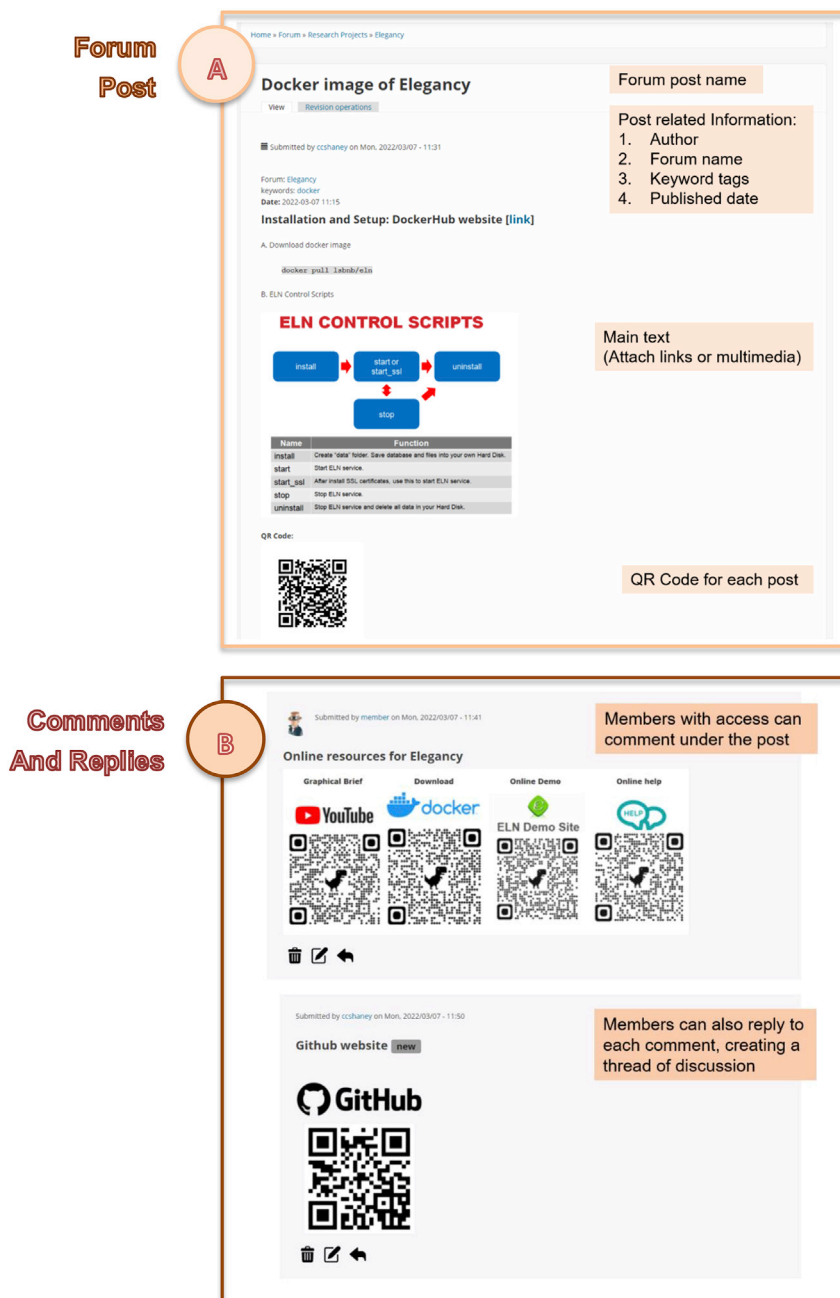
Most ELNs on the market offer a variety of service plans, yet the free version usually includes limited functions, storage, and resources. This is not the case with Elegancy. All the necessary functionalities are included in the same package, free of charge. We compared Elegancy with Elegancy based on a recent review of the highest-ranked ELNs (Kovac, 2021) and a comparison table between several ELNs (Harvard Longwood Medical Area Research Data Management Working Group, 2001), the free version of SciNote, and eLabFTW as shown in Table 1. Although eLabFTW only provides chemical drawing utilities, Elegancy is equipped with those, as mentioned earlier, mathematical and chemical tools. Generally speaking, Elegancy outshines these two ELNs in a handful of aspects. For a detailed comparison between Elegancy and the pricing plans for SciNote and eLabFTW, see Table S1.

### Optimized Docker image

Elegancy is built based on Drupal (Figure 7), allowing users to add personalized modules. It supports operating systems, such as Windows, Mac OS, Linux, and several web browsers, including Google Chrome, Firefox, Safari, IE, and Opera. We highly recommend choosing Elegancy's Docker image over local installation for several reasons: First, cloud backups can spare users the trouble of transferring or restoring databases between hardware storage devices. Second, it enhances data preservation security. Third, users can access their ELN from any device anytime and anywhere. The full online resources of Elegancy are shown in Figure 8. The basic hardware requirements to install Elegancy are shown in Figure 9 and the basic instruction for setting up our Docker image with these control scripts is illustrated in Figure 10.

### Data security and user authorization

Several aspects of the platform guarantee data security. First, we set up an SSL certificate upon installation to prevent unauthorized access and encrypt data during transmission. We allow only one web server portal to be opened and close all others to prevent any malicious invasion. We set the maximum number of login attempts to 3 times to prevent botnet attacks. Once surpassing this limitation, the user would be locked out for 5 min before signing into their electronic notebook again. Secondly, user access is divided into different levels of authority: *Guest*, *Lab Member*, *Project Leader*, and *Site Manager* (see Note S1 Section 3.1). Moreover, using the Docker images ensures remote data backup and easy

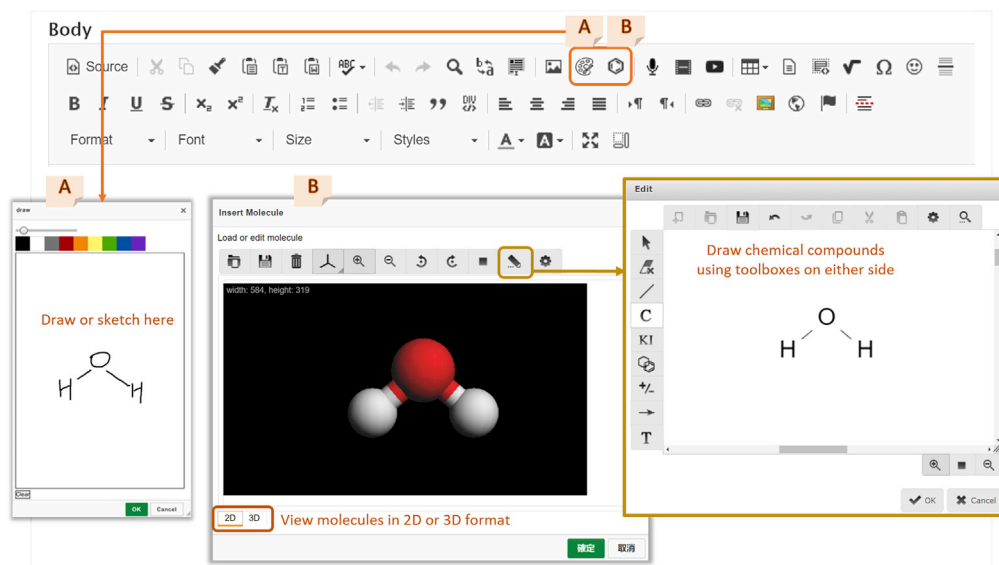


**Figure 3. Example of a forum post**

(A) Under each Forum, users can create posts with the text editor described in Figure 2. Multimedia and URL links could be attached to the main text. Information including author, forum name, and published time are shown on the top. A QR code is generated for each post at the bottom. Any alterations on this post are recorded in "Revision Operations" for safety measures.

(B) Members with access to this forum can comment under the posts and reply to one another.

database restoration. Not all ELNs address version control and timestamping, but these issues could greatly enhance data integrity (Higgins et al., 2022). We complied with the RFC 3161 Time-Stamp Protocol (Adams et al., 2001) and most of the main requirements regulated by CFR Title 21 Part 11 (U.S. Food and Drug Administration, 2020). The five specific requirements of CFR 21 Part 11 are validation, audit trails, legacy systems, copies of records, and record retention. We cannot fulfill the requirements

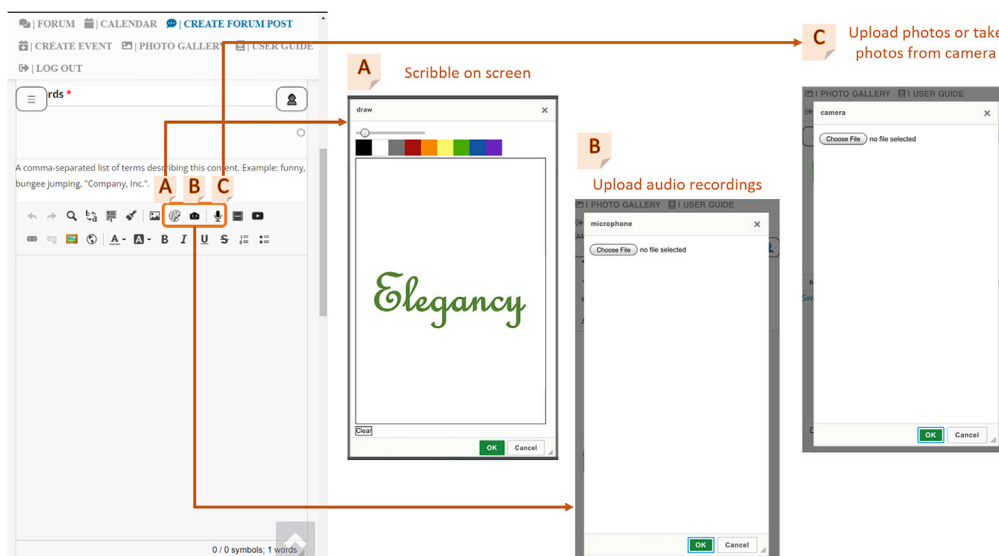


**Figure 4. Features developed for biomedical researchers**

(A) Users can sketch their scientific findings directly on their screens.

(B) Users can either upload saved JSON or CML files of molecule structures or edit a new one using the panel's toolbox.

for legacy systems and parts of audit trails as we do not provide the electronic signature service. The current version of Elegancy offers a computer-generated, time-stamped audit trail including all records except for digital signatures by users: date, time, and actions such as create, modify and delete. We believe these functions are sufficient for now as Elegancy is not commercial-oriented, and we do not profit from it. The free version of eLabFTW only complied with RFC 3161, while the free version of SciNote does not apply to audit trails. Nevertheless, we may include electronic signatures in the future releases of Elegancy in the form of an optional function. For example, we are considering introducing a blockchain infrastructure for scientific Research, Bloxberg (<https://bloxberg.org/>), as a module of



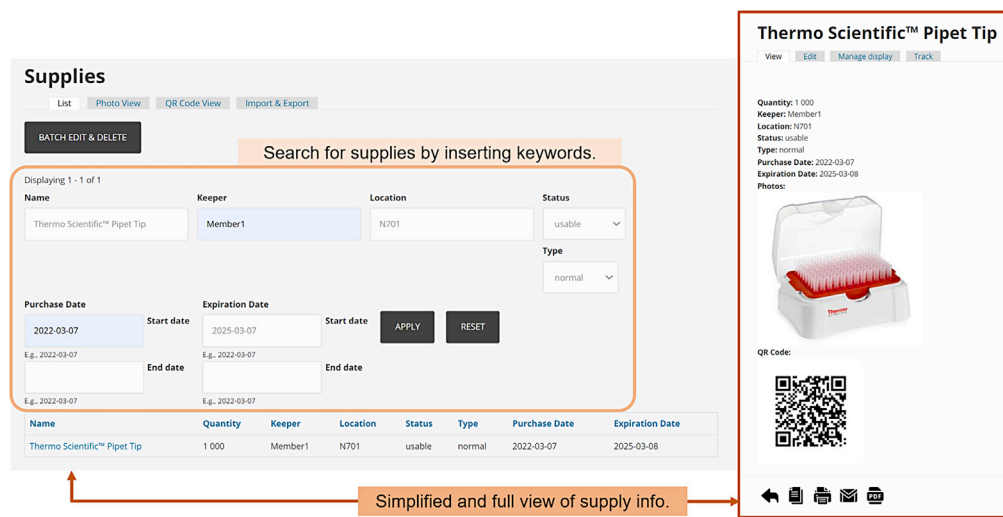
**Figure 5. The interface and special features of Elegancy on mobile devices**

Three special features are developed for users utilizing Elegancy through their mobile devices.

(A) Users can record an audio file or upload saved recordings from their devices.

(B) Users can take photos directly from their camera or upload images saved on their devices.

(C) Users can doodle or write on their screens and upload them directly.



**Figure 6. Supply and property management**

Members can search for supplies or properties by typing in keywords. Information regarding said supply or property will be displayed in a simplified list beneath the search bar. By clicking on the name, users can see a detailed view of the object similar to the image on the right, including a photo and qr code.

Elegancy, to create a transparent footprint of each scientific record without revealing its content. Such an approach will comply with FDA or healthcare data privacy requirements.

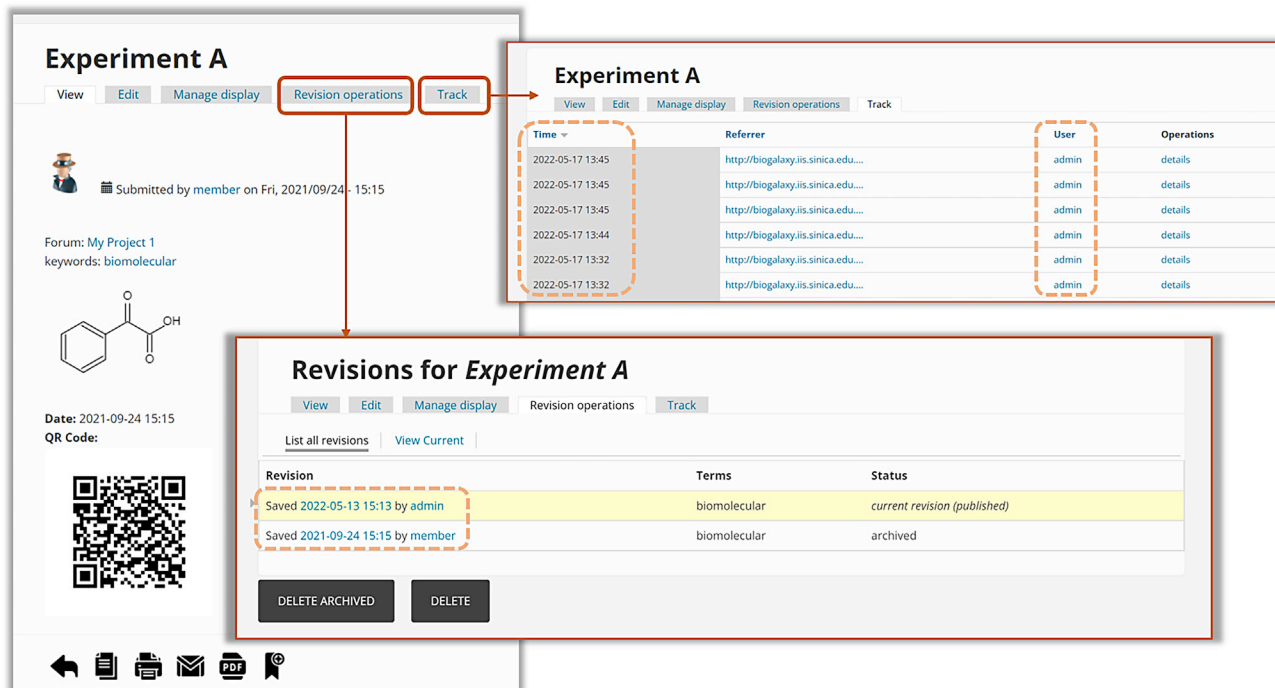
All events and modifications are recorded according to username, date, and time as illustrated in Figure 7: which displays the list of revisions on this post. It marks the current version in the “status” column. Only members assigned to this forum have access to these revision records. By clicking on the “Track” icon in Figure 11, users can also view all records of interaction related to this specific forum post, i.e, which members viewed, edited, commented on, or shared this post. This list of records is available to site managers only by default but could be accessible to all lab members by choice. Finally, as we don’t provide any form

**Table 1. Comparing elegancy with the free version of SciNote and eLabFTW**

	SciNote (Free)	eLabFTW (Free)	Elegancy
Number of users	1 user	unlimited	unlimited
Arrange meetings via ELN	X	X	V
Properties and supplies record	X	X	unlimited
Code insertion	V	V	V
Insert Math-Type	X	X	V
Chemical compound drawing	X	V	V
Suitable web interface for mobile devices	low performance in editing	V	V
Take photos with mobile devices	X	V	V
Record audio and scribble with mobile devices	X	X	V
Open-source software	V	V	V
Local Hosting	X	V	V
Cloud Hosting	Public	Requires own server	Requires own server
Data backup and restoration	V	V	V
Docker image	X	V	V
Audit Trials	X	RFC 3161 Compliant	RFC 3161/21 CFR Part 11 Compliant <sup>a</sup>

<sup>a</sup>RFC 3161/21 CFR Part 11 Compliant: Follows Time-stamp protocol of RFC 3161; Follows validation, audit trials, copies of records, and record retention but not legacy systems (the implementation of electronic signatures) of CFR Title 21 Part 11.





**Figure 7. The basic structure of Drupal**

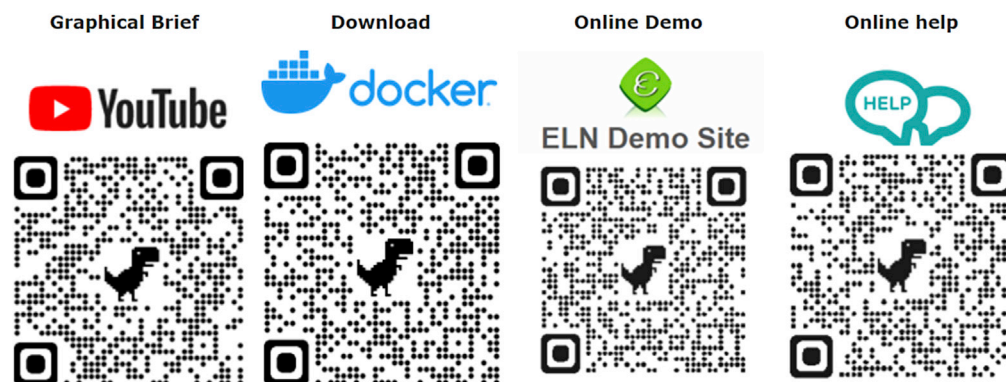
The first layer is the input of nodes as data. The second layer is modules, i.e., functional plugins that are either part of the Drupal core or are created by members of the Drupal community. Modules allow users to customize and rearrange the data on their nodes. The third layer is blocks and menus: Blocks provide the output from a module and can be configured to output in various ways, from only showing on certain pages to only for certain users; Menus are not only navigators in Drupal, defining the content coming on each defined menu path but also a core element of Drupal which provide links to all the pages created in Drupal. The last layer is user permissions which determine what users can execute and read.

of data hosting or pricing service, data stored on the users' device, cloud or server should also warrant data security and confidentiality.

Elaboration on Elegancy's complete functions is provided in [Note S1](#).

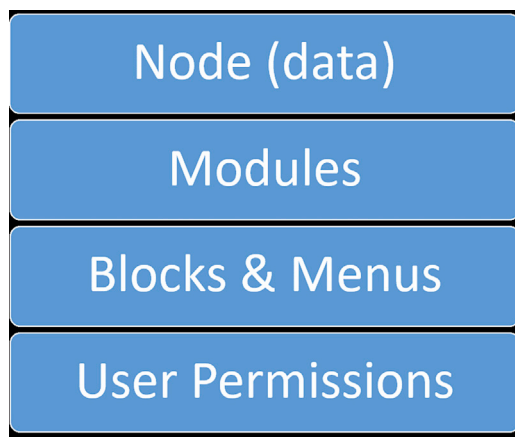
## DISCUSSION

In summary, Elegancy offers many functions for all types of research labs, especially biomedical research. It supports both local and cloud hosting, which are available with a Docker image. The installation steps are simple, and the user interface is intuitive. Tutorials of Elegancy's basic functions and an



**Figure 8. Online source for elegancy**





**Figure 9. System requirement for elegancy installation**

The basic hardware criterion for Elegancy implementation is a system with at least 1.6 GHz CPU, 4 to 8 Gb RAM, and a minimum of 300Mb storage. We recommend leaving an additional 100Gb to 1Tb storage for those uploaded data.

introduction video of the overall features are provided online. Elegancy is compatible with several operating system layers and can be accessed anywhere through any electronic device. It also includes special features specifically for mobile device use. Most importantly, Elegancy is charge-free for all users.

#### Limitations of the study

Elegancy continues to develop and is expected to receive several feature improvements: First, our team plans to add an auto-reminder function for time-consuming programs or experiments. Second, modern laboratory equipment typically supports exporting results in a digital format. Therefore, we attempt to develop a function via Application Programming Interface (API) that directly inputs experiment data into the ELN under a folder specially created for this purpose. As it is impossible to conform to every kind of data format, we may start by extracting keywords such as the basic information shared by most formats (time, date, size ... e.t.c.) and then continue to customize them in the future. Third, the Jupyter notebook (<https://jupyter.org/>) is widely used and indispensable to many laboratories. Thus, binding the Jupyter notebook to our ELN would benefit those highly dependent on it.

Moreover, it is proved feasible to create semantic documentation for research data using ELN protocols from wet-lab experiments (Schröder et al., 2022). Similarly, our team hopes to be able to not only import protocols from web pages, such as Protocols.io (<https://www.protocols.io/>), but sync the database to our ELN to assist in extremely complex experiments with numerous detailed steps. Finally, we plan on

## SYSTEM REQUIREMENT

### CPU

- At least 1.6 GHz

### Memory

- At least 4~8 GB

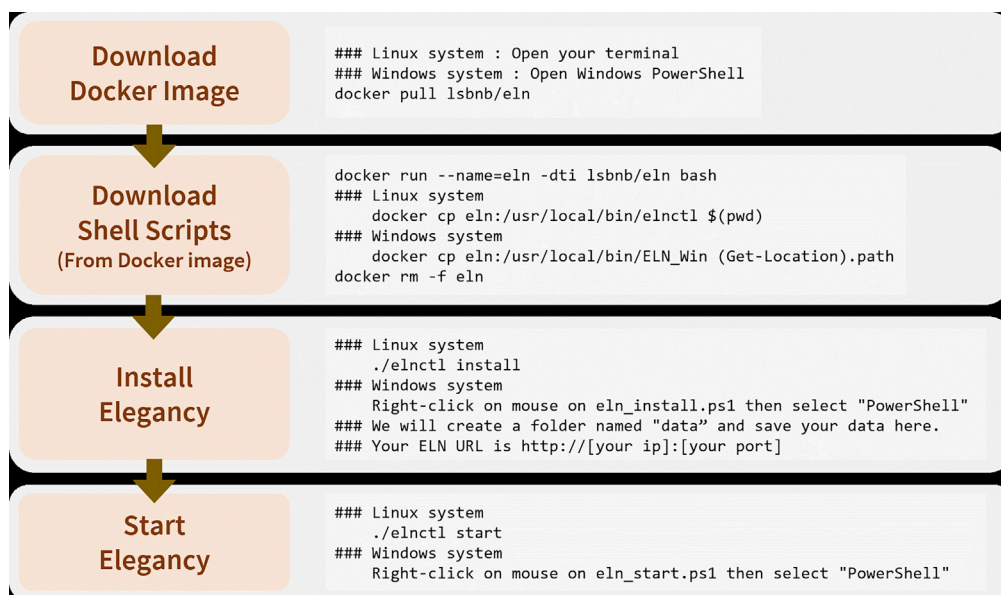
### Hard disk

- A minimum installation requires 300 MB
- Suggest remaining 100 GB ~ 1TB free space for your files and images.



**Figure 10. Basic instructions for elegancy Docker setup**

Elegancy has four steps: Downloading the Docker image, getting shell scripts, installing, and starting Elegancy. Here, we provide the required commands for Linux, MAC, and Windows systems.



**Figure 11. Revision records and user interaction tracking on forum posts**

Following RFC 3161 Time-Stamp Protocol and CFR Title 21 Part 11, Elegancy records any revision on a forum post as displayed in the figure above revision time, revised by who, terms, and status. Only members with access to the forum can view this list of records. Another similar function is tracking any interaction related to this post, such as the time and person that visited this post, and so forth. This function is accessible to site managers only by default but could be open to all members.

including electronic signatures as an optional function for audit trails. Users can enable this feature based on their needs.

## STAR★METHODS

Detailed methods are provided in the online version of this paper and include the following:

- KEY RESOURCES TABLE
- RESOURCE AVAILABILITY
  - Lead contact
  - Materials availability
  - Data and code availability
- METHOD DETAILS
  - Fundamental structure
  - Installation and implementation

## SUPPLEMENTAL INFORMATION

Supplemental information can be found online at <https://doi.org/10.1016/j.isci.2022.104710>.

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## AUTHOR CONTRIBUTIONS

System development – C.W.H. and C.Y.L.; article writing – W.H.C. and C.W.H.; article review & editing – C.Y.L. and S.H.C.

## DECLARATION OF INTERESTS

The authors declare no competing interests.

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## STAR★METHODS

## KEY RESOURCES TABLE

REAGENT or RESOURCE	SOURCE	IDENTIFIER
Software and algorithms		
Drupal 7	Dries Buytaert	<a href="https://www.drupal.org/drupal-7.0">https://www.drupal.org/drupal-7.0</a>
MySQL 8.0.25	Oracle Corporation	<a href="https://www.mysql.com/">https://www.mysql.com/</a>
Apache HTTP Server 2.4.41	Apache Software Foundation	<a href="https://httpd.apache.org/">https://httpd.apache.org/</a>
PHP 7.1.33	The PHP Development Team, Zend Technologies, PHP Foundation	<a href="https://www.php.net/">https://www.php.net/</a>
CKEditor	CKSource	<a href="https://ckeditor.com/">https://ckeditor.com/</a>
Docker	Merkel, 2014	<a href="https://doi.org/10.5555/2600239.2600241">https://doi.org/10.5555/2600239.2600241</a>
SSL Certificate	SSL.com	<a href="https://www.ssl.com/">https://www.ssl.com/</a>

## RESOURCE AVAILABILITY

## Lead contact

Further information and requests for resources and reagents should be directed to and will be fulfilled by the lead contact, Chung-Yen Lin ([cylin@iis.sinica.edu.tw](mailto:cylin@iis.sinica.edu.tw)).

## Materials availability

This study did not generate new unique reagents.

## Data and code availability

- Data: Upon each download of Elegancy, we collect the basic information of our users, i.e., download time, IP address, user name, affiliation and e-mail, via a questionnaire survey. The results are shown in the Supplemental Information.
- Code: Docker image of Elegancy is freely accessible at both <https://hub.docker.com/r/lbnnb/eln> and <https://github.com/lbnnb/eln>.
- Any other information: We also provide a demo website for potential users at <https://elncld.iis.sinica.edu.tw/elndemo/en/home> and a thorough user guide at [https://elncld.iis.sinica.edu.tw/eln\\_document/](https://elncld.iis.sinica.edu.tw/eln_document/). A brief introduction video of Elegancy is available here: <https://www.youtube.com/watch?v=KXOa5WNytCM>. Meanwhile, detailed information about deployment, installation, setting, and system management is described in supplementary.

## METHOD DETAILS

## Fundamental structure

An open-source content management platform, Elegancy is developed based on Drupal 7 (<https://www.drupal.org/drupal-7.0>). The entire platform of Drupal consists of four layers: nodes, modules, blocks & menus, and user permissions. It regards all content as a node, behind which many modules control its display, modification, arrangement, and classification. More deeply, Drupal also uses blocks & menu. Blocks often provide the output from a module or can be created to display whatever the user wants and then can be placed in various spots in customized template layout. Menus are a core element of Drupal, providing links to all the pages created in Drupal. Finally, permissions determine what users are allowed to do and see. This design allows Drupal not only to create an ordinary blog site but control the way content is displayed and handle permissions with appropriate components. It can instantly become a forum, wiki, personal website, social network, and shopping site.

A total of 190 operating modules are in the system of Elegancy, including core components, the management interface, content creation, data sharing, search engine capacity, panel construction, multilingual support, information safeguarding, and backup and restore capabilities. Among those modules, 170 are modified from the built-in modules, and 20 are constructed by our research and development team. MySQL 8.0.25 (<https://www.mysql.com/>) was used to establish the database, and Apache HTTP Server

2.4.41 (<https://httpd.apache.org/>) was used to set up the webserver. The programming languages implemented here are PHP 7.1.33 (<https://www.php.net/>), HTML and CSS. CKEditor, a WYSIWYG text editor specially used on web pages and belongs to open source code, is the main module implemented in Elegancy. It aims to be lightweight and can be used without over-complicated installation steps. There are a handful of plugins that can be used together with CKEditor. All is possible within a single editing framework from editors similar to Google Docs or Twitter-like applications. Users can add text, programming code, chemical formulas, math equations, hyperlinks, handwriting, table, image, audio, video, or any file. We also added some customized plugins to the default settings, i.e., the three features developed for mobile devices: audio recording, photo uploads, and doodling on screen. These additional customized features are compatible with all versions of CKEditor.

### Installation and implementation

To ensure that even users without a background in computer science can easily navigate Elegancy, our team focused on developing an ELN that can be swiftly installed by following simple instructions. Elegancy supports both local and cloud installation. With Inno Setup as the foundation for local installation, we wrapped software packages, such as Apache, MySQL, and PHP, into our installation program. We also included JRE in the package because Java was used in writing programs related to ELN management, which are required for initiating and shutting down ELNs. Local download is currently available for Windows only. However, with the Docker image we provide, the software mentioned above packages are wrapped with the Docker developer, allowing users to install and build their ELNs on different operating systems (e.g., Linux and Windows), DOCKER environments, NAS drives, or cloud computing platforms. To save users from learning complicated Docker commands, we offer a Shell Script with the required commands for installation written inside with no code. For more detailed tutorials, please visit our user guide website: [https://elncloud.iis.sinica.edu.tw/elc\\_document/](https://elncloud.iis.sinica.edu.tw/elc_document/).