

Because of the dynamic nature of insect collection management, a virtual museum consisting of digital images of entire drawers of specimens will represent only a snapshot of the collection as it existed at the time it was digitized, and the static images will become outdated over time. For example, unidentified specimens are sent out on loan to expert taxonomists who identify them (adding ID labels to the specimens), and when they are returned, the collection manager inserts them into the appropriate place based on the new identification labels. Although these kinds of changes tend to occur slowly overall (specimen loans are usually made for a minimum of 2 years and they are often renewed many times before the specimens are returned to the home institution), we still need to find efficient ways to update the virtual museum to reflect changes in the organization of the collection. This is important because at least some researchers using the virtual museum will ultimately need to examine the actual specimens, given that there are limits to the amounts and kinds of data that may be gleaned directly from the images. Thus, when a researcher sends a loan request for particular specimens based on his/her study of the digital images, the person in charge of the collection will need to be able to find the specimens of interest in order to process the loan request; and when the loan is returned with specimens identified, the database will need to be updated to incorporate the new information on specimen identifications as well as the new locations of the specimens in the collection.

Current systems for tracking the scientific names and locations of individual specimens, using specimen-level databases and UID labels, work reasonably well, but because most specimens in most collections have not yet been databased, we have an opportunity to develop more efficient, alternative tracking systems without undoing or abandoning everything that has been done previously. Nevertheless, INHS and several other collaborating institutions have already compiled specimen-level databases for portions of their collections (and added UID/barcode labels to the databased specimens). Thus, another challenge will be to link the new digital image data with the existing specimen database records, in addition to imaging and databasing the larger parts of these collections that have not yet been incorporated into databases.

The specimen digitization and tracking system outlined in our proposal (which we may or may not decide to adopt) retains some aspects of the old system, but assumes that we can automate certain steps in the digitization process. Specifically, we assume that:

We will be able to obtain images of whole drawers that are detailed enough to be able to glean most of the specimen label data from the images

We will be able automatically to segment the whole drawer images such that an image of each individual specimen (and its labels) is placed stored in a separate image container

From these separate specimen/label images, we will at least partially automate the capture of label data such that the data are placed into appropriate fields in the database record for each specimen (basic fields include, e.g., country, state, specific collecting locality, date of collection, name of collector, species name, etc.)

Each specimen will be assigned a unique identifier to facilitate future tracking.

We plan to continue using UID labels to link each specimen to its database record, but suggested in the proposal that the physical labeling of specimens could be deferred until it becomes necessary to move the specimen from one physical location to another (either because the specimen has been requested on loan, or because it has been identified or re-classified in situ and

needs to be moved to a different location in the collection. This reduces the risk of specimen breakage due to excessive handling. Nevertheless, because most specimens will not, initially, have unique identifier labels, the digital images of the specimens will need to be annotated so that collection managers will know which one is which based its exact location, relative to other specimens, in the unit tray and drawer. One might imagine using augmented reality technology to superimpose a virtual grid over each drawer of specimens (or otherwise highlight the specimens of interest) to aid the collection manager in locating the specimens of interest without having to make a side-to-side comparison of the digital image to the actual drawer. Ideally, it would be desirable to build some sort of automated feedback mechanism that tracks specimens on the fly as they are being moved around, such that their database records could be updated to reflect their loan status and/or new location in the collection. Similarly, when entire unit trays or drawers are moved (as, for example, when a particular species is reclassified and placed in a different genus), it would be desirable to track these higher-order collection storage units in addition to the specimens contained within them.