

Quick Guide to the prototype of the Biomimicry Database

What's Done, And How It Works

The original plan was for a FileMaker database bolted to some html. Instead, we made an integrated SQL/PHP application that is a database, a moderated wiki / meta-journal, a knowledge-organization tool, and a community forum.

Features of the Prototype System:

- Searchable Relational Database
 - The system has six main data types: Challenge, Strategy, Organism, Person, Citation, and Product.
 - Challenges are problems that need solving.
 - Strategies are potential solutions to those problems; almost all are biological solutions, but for completeness in some areas, human-invented solutions are listed. Besides strategies' descriptions, the records are classified by what type of strategy they are (pattern / process / system), what level they operate at (cell / organism / ecosystem, etc.), and whether they are biological or technological. The records may also include explanatory/exemplifying images.
 - Organism records describe specific organisms, listing their taxonomic categorization, a description of what the organism has/does that might be inspiring, and data on the organism's environment (both habitat name, such as "freshwater riparian" and conditions: range of temperature, humidity, pH, salinity, and pressure.)
 - Person/User records contain a description of the person, contact information, an image, checkboxes to classify them by profession / field of study and whether they are an expert in their field(s), a listing of the user's personal ontology for data in the database, if they have created one, and a listing of all records in the database created by that person. When the system is opened up to collaboration, the latter two listings will be useful for contributors wishing to build their credibility in the system (such as researchers looking to do contract work for product companies). User records also have a "help wanted with" field, where users can ask for help on subjects; searching this field could be good for students in search of research projects, or professional researchers looking to contract their services. Person records are crucial to the system, because the database is

intended not only as a place for users to find knowledge, but also a place to find the experts they need. This could ideally lead to consulting contracts and/or cross-disciplinary collaborations between biologists and engineers.

- Citation records contain basic bibliographic information and abstracts for papers referred to in Challenges, Strategies, or other records. They are there both to support the veracity of claims in the Strategy and Challenge records, but also to provide sources for further research on their respective topics.

- Product records have descriptions of biomimetic products, including company's name and contact information and checkboxes showing whether the product is actually available or still in development.

- Searchability

- Because it is a database, the system can be searched in specialized ways which wikis and the web cannot, using the Advanced Search page. (e.g. search only for organisms whose descriptions contain "adhesion" and whose phylum is "mollusca".)

- The system should be indexable by Google, so that doing a normal web search for some specialized terms could bring people to our database. Other collaborative knowledge sites (such as Thinkcycle) can't even find data within the site's own search engine, much less appearing from a blank search of the web. The system's indexability has not yet been tested.

- Data Interrelation

- Every record contains a list at the bottom for Related Records. These links connect the record with supporting data, e.g. a product that employs the method listed in a Strategy record, researchers who are experts on the problem listed in the Challenge record, etc.

- Modularity

- The separation of ideas into Challenges and Strategies (plus sub-challenges and sub-strategies) allows users to break a topic into manageable-sized chunks for division of labor. Once broken into chunks, the subtopics can then also be reorganized by other people like Legos in their own research agendas. (see Browse, below.)

- Browse

- Browse hierarchies allow users to search not only "horizontally" by keyword searches, but also "vertically" like a table of contents. Finding one record by keyword can lead to finding a whole category of records in the hierarchy, which would not have been found by keyword alone.

- Users can create their own Browse category schemes (one per user, though group accounts can be set up which all members of a group have access to, allowing an unlimited number of schemes). This will allow users to not just find information, but organize it for future reference and even create new hierarchies of knowledge, a rough ontology-creation tool. This will also help researchers expose gaps in knowledge, by seeing "holes" (areas of minimal or no data) in ontological trees.

- Comments

- Each record in the database can have comments attached to it, and any registered user can leave comments. (People without accounts cannot, as that would leave the system open to automated spam programs.) This will provide an arena for discussion/collaboration, by allowing users to write comments on entries. Users can also put comments onto their own Person page (or the Person page of a group account), turning their page into a blog; if other people add their comments, it becomes like a bulletin board. This can make the application not merely a tool but a "community of practice".

- Multi-User Access

- Though a few bugs remain, the system should provide multi-user access with different levels of access-privileges. This is how we can have a moderated open-source system. Such a system will:

- provide a larger pool of data contributors, but retain quality-control of submitted data
- create more involvement with users
- hopefully build reputations of talented biologists / engineers / designers / etc. who contribute, by giving them authorship credit and a stage upon which to show their expertise
- allow users to flag problem areas: topics they want help with, or challenges that need strategies associated with them.

- Kinds of users and their access levels are as follows:

- Public: Does not require a login. Can view records, but cannot edit anything or leave comments.
- Registered Public: Requires a login. Can view records and leave comments, has their own Person Page and category scheme which they can edit, but cannot edit any other records.
- Contributor: As Registered Public, but can add records of any type, and can edit/delete records they created. Records they add or edit will be tagged as "not yet reviewed".
- Reviewing Contributor: Can add records of any type, and can edit records other users created as well as their own, but cannot delete others' records. Can tag records as being reviewed, removing the "not yet reviewed" label from them. Can delete comments by other users.
- Group Leader: as Reviewing Contributor, but can also add/edit user accounts.
- Database Team: Can do anything in the database except reprogram it
- Administrator: Can do anything.

Where The Prototype Will Be Used In Its Current Form

- For Biomimicry Guild research
 - Hopefully the system will be useful for many researchers and designers. But even if not, it will at least be a valuable tool for us. It will help us organize the data we have gathered over the years on biological phenomena, researchers, and products; it will also help us interconnect the better. Organization and interconnection turn mere data into useful knowledge. It would make us more valuable consultants, which would boost the movement of biomimicry in a trickle-down way.
- For anyone's research
 - We hope the system will prove useful to many researchers and designers besides ourselves, which would lead to more cross-discipline knowledge sharing and more biomimetic inventions and research. We do not yet know whether it will succeed in this; user-testing and iterations of the system will have to be done.
- For teaching a biomimicry course
 - When teaching a course on biomimicry, the database can be a resource for students and instructor alike: it would be an organizational tool for the teacher, and a knowledge source / expert simulator for the students.
 - The instructor can use the category-scheme creation tool to provide a handy outline of challenges and strategies to mention in class, or show the web of dependencies between a certain product and the research that made it possible.
 - Students can use the database as any researcher would, or to simulate talking to an expert on the subject they are searching for.

How To Use The Prototype In Its Current Form (Step-By-Step Examples)

- Log in to the database.
- Enter the search term "Fire" in the Search box and press Go. A list of hits will appear in the window's main frame, including all Challenges, Strategies, Products, People, and Citations containing the keywords in any of their fields. Notice that the records are color-coded by type; this color coding persists throughout the database.
- Click on the challenge "Fire Protection". That record will appear in the main frame, including its description and links to other related records. The Browse list in the left frame will also update to show where the record is in the selected category scheme.
- In the Related Records list, scroll down and click on the Challenge "Fire Detection". When that record appears, notice that along the left-hand side of the main frame there is a striped bar saying "Not Yet Reviewed". This would appear on all records that have been entered by a third-party contributor but not yet approved by a moderator of the database.
- Scroll down to its Related Records list and click on "Black Jewel Beetle". After reading about the beetle, scroll to the bottom and notice the comments.
- In the green "Comments" title bar, click "Add Comment". The page to add a new comment appears. Scroll down to the field labeled "Body" and type some text for a

sample comment (ignore all other fields.) At the bottom of the screen, click "Make These Changes". You will be returned to the Black Jewel Beetle page, with your comment added to the list.

- Click on one of the "back to top" buttons. This brings you back to the top of the record.

- In the green title bar, click "add to saved". This adds the record to your clipboard of saved records.

- Scroll up to the top of the page, and in the Browse frame, go to the pulldown menu and select [My Clipboard], then click the Go button. The Browse list will refresh, and at the bottom of the list you will see the record you just added. Notice that the records listed in the Browse frame are color-coded by type, just as they are in the main frame.

- Notice that one of the items in the list overflows onto two lines. Go to the grey bar separating the browse frame from the main frame, and click on the right-pointing arrow to expand the frame. You may do this as many times as you wish.

- In this divider bar, click the little box above the arrow buttons. This collapses the Browse bar entirely. Press the right arrow again to return it to normal.

- In Browse frame, click the text "Adhesion / Joining". This pulls up the Challenge by that name.

- Go to the browse pulldown menu and choose "Biomimicry Guild scheme", then press Go. Notice that although the list in the Browse frame changes, "Adhesion / Joining" is still highlighted, because it is being viewed in the main frame.

- Click the + sign by "Adhesion / Joining", then the + sign by "Bond Surfaces", then click on the text of "Adhesion: Cement". This record appears in the main frame.

- Scroll down to Related Records: Products and click on "DOPA two-sided coating". After reading this record, scroll down to its related records and select "Dr. Phillip Messersmith".

- Here, scroll down and click on Related Records: "Glue", and notice when this record pops up that in the Browse frame its name is highlighted.

- In the top frame, below where it says Search, click on Advanced Search. The advanced search page will appear, and you can scroll all the way down to see the different fields that can be searched.

- In the User section of the Advanced Search page, find "Desc" (Description) and in the blank box to its right, type "whale". Scroll down to the field "Country", and in its box type "Germany". Click on any button that says "Search". This will pull up a list of all people in the database who are in Germany or who study whales.

- Notice the first name on the list is "Dr. Christof Baum". Click the Back button on your browser to return to the Advanced Search page, and in the "Name" field under the User heading, type Baum. Go to the pulldown menu to the left of the text box, and instead of using "Search", which is the default, choose " - Ignore". Click any Search button. Notice that the results were as before, except that Dr. Baum does not appear in the list.

- Click the Back button on your browser again, and in the Advanced Search page, go to the pulldown by Name, where you have the text "Baum", and choose "Search"

from the list instead of " - Ignore". Then click any Search button. Notice that now the user "Dayna Baumeister" is added to the list, even though she does not study whales and is not in Germany.

- Click the back button on your browser again, and in the Advanced Search page, delete the text you have in the Name field. Leave the text "whale" untouched, and scroll down to "Country", where you still have the text "Germany" entered. In the pulldown menu there, choose " + Required" and click any Search button. Notice that now only Dr. Baum appears in the results list, because he is the only researcher in the database that studies whales AND is in Germany.

What Remains To Be Done, And When We Plan To Do It

The database, as it stands, is far from a finished product--it is merely a first prototype. Even the features that are implemented already have many bugs and shortcomings of implementation. Cleaning up these bugs and finishing the implementation of existing features are significant tasks in and of themselves, and we would expect these tasks to take at least six months after receiving funding and hiring full-time staff.

Bugs to fix in first six months after receiving funding:

A complete list would be too long to include here, but some significant fixes to be implemented are:

- Many display bugs / interface inadequacies will be fixed. (Especially on the Edit side of the database, which currently has no graphic amenities, and so is confusing and user-hostile. But many problems remain in the View side of the database.)
- Data-merging bugs that resulted in lost or altered data will be fixed.
- User access bugs will be fixed, ensuring that different kinds of users have the appropriate capabilities.
- "My Clipboard" will be able to be saved as a file, emailed, or printed.
- Advanced Search will include checkboxes, Related Records, and Comments fields.

Features to add and tasks to do which could be completed within a year of receiving funding:

- User-test and iterate the design of the system, to ensure it is useful to many researchers and designers besides ourselves.
- Improve the amount and quality of data. A possible benchmark would be to quadruple the amount of Product data and People data; double the amount of Challenge and Strategy data, increase citations by 50%, and interlink and organize all records thoroughly.
- Have three or four relatively complete category schemes for users to browse by, which are very different from each other and appropriate to users in different fields. (for instance, TRIZ and IEEE, in addition to the Biomimicry Guild and CSI master Format schemes.)
- Improve searchability:

- Add the ability to sort search-hits by relevance, creation date, modification date, popularity, record type, record author, possibly other attributes.
- Add Google weighted-search capability within the database.
- Test external Google indexability, and improve if necessary.
- Add more interactivity to the database:
 - The ability to email users with notification of new records or comments, if the users so choose.
 - The ability for users to select what data gets displayed in lists of search hits, or in their Saved Records list. Currently only record title and summary are displayed.
 - Possibly add the ability to chat, in addition to just leaving comments.

Wish-list of features we would like to add in the future, but would require more than a year of funded work, and/or help from other organizations:

- Include full-text citations. (Requires copyright permission as well as more programming)
- Visualization tool for the interconnections between records, such as ThinkMap. (Requires programming and funds to purchase tool.)
- Clustering tool to auto-generate ontologies, such as Vivisimo. (Requires programming and funds to purchase tool.)
- Compatibility with other databases (PubMed, ScienceDirect, etc.) Ideally we would not only be able to import/export data between databases, but have real interoperability, where searches in our database can pull up links to records in other databases. (Requires both significant programming and cooperation by owners of the other databases.)
- Latent Semantic Indexing of records to improve search results (this would require many more records, more programming, and the cooperation of experts in LSI.)