

D-Lab 2 Final Report

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Drycard Production Process

1. Design Brief: Project Statement & Client Background

Our team consists of Anindito Wibowoputro, a fourth year undergraduate majoring in Economics, and Anna Gomes, a third year undergraduate in Agricultural and Environmental Education. Under the mentorship and guidance of Dr. Kurt Kornbluth and Mr. Peter Nasielski, our project goal was to establish a manufacturing method to produce approximately 1,000- 10,000 DryCards for field trials in Africa and South America. Previously, the card was produced using a home-use laminator machine in our client's office through a rather time-consuming process. Our client presented us with two goals for the design process: consistency of alignment and reduced labor. By developing a faster, cheaper, and simpler method to produce Drycards, their impact can be accelerated in time and in space.

Our client Mr. Jim Thompson, a retired director of the UC Davis Postharvest Lab in conjunction with the UC Davis Horticultural Innovation Lab, designed the DryCard and has been working to amplify its' impact. Our target customers are small-to-medium scale farmers in developing countries (ex. Africa and South America for initial outreach) and traders of dried commodities (seeds, nuts, grains, etc.). However, the production process is targeted towards small local businesses in developing countries who will produce the cards in-house and sell them to these farmers and traders.

For more information about the Drycard, please visit:

https://blog.horticulture.ucdavis.edu/2017/03/inventing-a-low-cost-solution-dryness-indicator/?utm_campaign=drycard-inventing&utm_medium=email&utm_source=newsletter-170511 You're

2. Design Process and Methodology: Criteria and metrics*2.1 Evaluating Benchmark Design Process*

Process	Room for improvement?
1. Print sheet of 10 Drycards with writing on both sides	Order the cards already printed and cut
2. Cut up the individual cardstock cards	Could use paper cutter to speed up the process
3. Cut the indicator strips inch & ½?	Yes, need system with preset measurements also method to flatten
4. Cut out a rectangle on the paper	Yes, die-cut press for improved precision
5. Cut a hole in the back side of the laminator slip	Yes, hard to line up, possible to cut both holes at once? Build wooden or metal template to hold all components in specific place when assembling or lever operated?

6. Place indicator strip in hole on card	Something to keep it from wanting to move. Lightly warm the laminating envelope so that indicator stays in place prior to laminating?
7. Hold card, laminator slip, and indicator slip and enter into laminator	Must be a better method, do more than one card at once?

2.2 Constraints

1. Card must be uniform in reproduction- minimizing room for human error
2. Card must be business card size at most
3. Card must be resistant to high humidity (sealed as much as possible)
4. Card must be laminated on both side, with a cutout on one side
5. Card must give reading in 20-30 minutes accurately
 - CoCl₂ strip cannot touch cardstock in order to perform accurately
 - Must be easy to read from both sides
6. Card must be light in weight and inexpensive for purchasing
7. Card must be durable for multiple use
 - Must determine product lifetime
8. Card to be produced locally
 - Minimized material outsourcing
9. Card production has to be simple enough for low-skilled workers
10. Card production method to be recreated for medium scale production
 - 1,000 - 10,000 qty

2.3 Must Haves

- The card must have color scale next to the CoCl₂ strip for easy and accurate reading
- Must have a window for the CoCl₂ strip to react to the surrounding environment
- Card must be rigid to maintain durability
- Must have protective seal around the card to prevent moisture from coming in

2.4 Would Likes

- Waterproof sleeve to protect CoCl₂ strip
- Glow in the dark Drycard for 24-hr. use or dimly lit environment
- Waterproof ink/seal around the CoCl₂ strip to prevent the salt from leaching onto the card

2.5 Criteria & Metrics Table

Criteria	Quantitative/Qualitative	Testing Procedure	Target Value	Metric (units)
Size of card	Quantitative	Measure card using ruler	3.5 x 2	Inches
Durability of card	Quantitative	Lab test with increasing levels of relative humidity in controlled atmosphere boxes	Rough average 84% Africa (Weatherspark.com, n.d.)	$RH = \frac{\text{(Actual Vapor Pressure)}}{\text{(Saturation Vapor Pressure)}} \times 100$ (Chlorine Chemistry, n.d.)
Aesthetics	Qualitative	Laminated border Legibility Positioning of the strip Minimal production residue	Visual inspection	N/A
Build Quality	Qualitative	Bending flexural test	Card does not bend easily when pressured	N/A
Speed of process	Quantitative	Measure throughput	100	Cards per hour
Worker strain during process	Qualitative	Set up inexperienced workers to make cards for X hours, survey/receive feedback	Overall satisfaction	Employee feedback
Simplicity of Equipment	Qualitative	To build all production equipments (tape cutter, die cut, template and holder)	Under 2	Hours

2.6 Design Concepts

Design Concept 1: Build small speedball press for cut outs

- Pros:
 - Easy to operate
 - Can cut multiple cards at once
 - Allows for uniform production
 - No electricity needed
 - Interchangeable block, standardized measurement

- Cons:
 - Room for error during printing



- Challenging to make
- Variable block placing, may cause inconsistency

Design Concept 2: Printing press using caulk gun

- Pros:
 - Easy to make
 - Anna has experience with wood
 - Light and portable
 - Can cut multiple cards at once
 - Enhances production automation
 - Reduce chances of human error
- Cons:
 - Low pressing power compared to lever mechanism
 - Durability
 - Variable block placement, may increase inconsistency unless block held in place



Design Concept 3: Printing press using roller

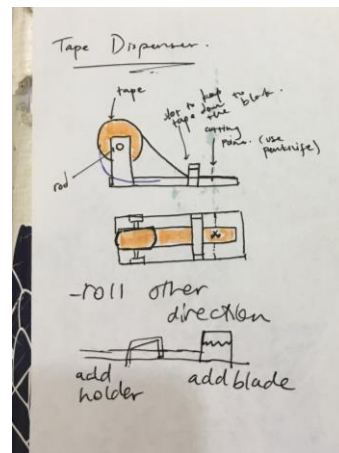
- Pros:
 - Little to no manufacturing
 - Cheap
 - Easy to make (need to make die wooden block)
 - Light and portable
- Cons:
 - Accuracy, wooden block might move when rolled
 - Pressure not uniform across the block
 - More physically demanding than the first two designs

Design Concept 4: Build tape dispenser for cutting indicator strip

- Pros:
 - Simple to make
 - Easy to operate
 - Cheap to make
 - Light and portable
- Cons:
 - Increases overhead cost

Design Concept 5: Make paper cutter for cutting cardstock

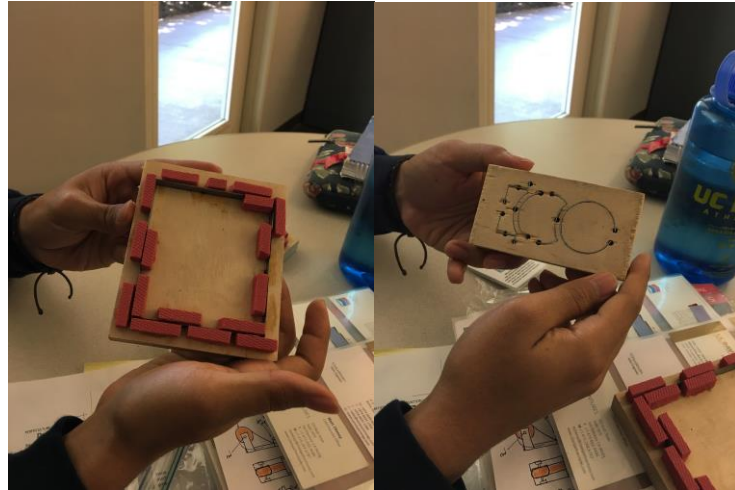
- Pros:
 - Simple to make
 - Cheap
 - Speed up cutting process significantly
- Cons:
 - Increase unnecessary overhead cost and labor hour



- Room for human error

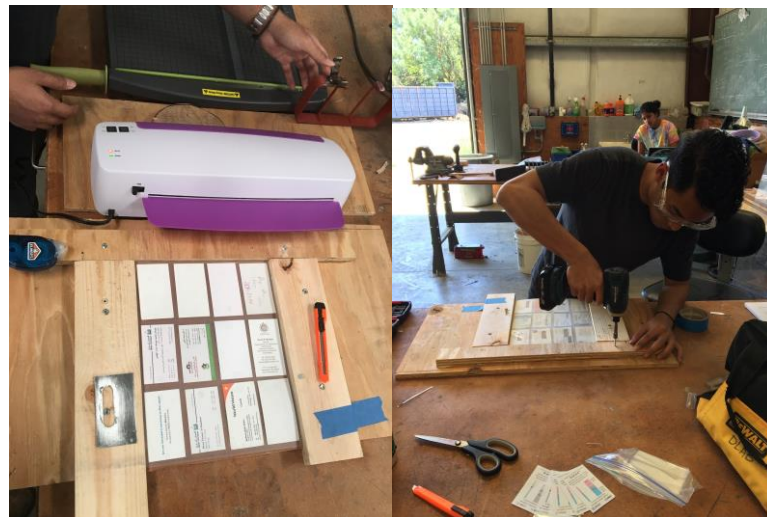
Design Concept 6: Build Punch

- Pros
 - Can cut multiple cards as once
 - Provides quick and clean-cut hole in Drycard
- Cons
 - May need to apply a large force to be successful



Design Concept 7: Build Template/Holder for Laminate Pouch & Card Layout

- Pros
 - Reduce opportunity for shifting or movement of cards
- Cons
 - Tricky to keep top flap of pouch open and pouch laying down flat



3. Results and Discussion: Include photographs, drawings

3.1 Evaluating & Testing

- a. Measure the time consumed to make different versions of the cards or
- b. Measure the time consumed for different production methods
- c. Test durability of card in humidity incubator, find percent RH for card destruction
- d. Cost. Materials and overhead.
- e. Ease of use; accuracy when compared to traditional moisture meters
- f. We tested our revised production process against our benchmark (original process)
- g. Prototype has potential to improve production efficiency to 72 cards/hr
- h. Prototype includes tape cutting device to allow for pre-made tapes
- i. Our production process does not change card design and function





3.2 Tested Ideas:

1. Production table (business card size lamination pockets)

- a. **Features:** Adjustable height, card fastener, CoCl strip cutter
- b. **Additional Features:** Cutting mechanism for card
- c. **Why we like it:**
Increased production efficiency by having 3 cards on the table at any one time
Built-in cutter improves consistency
Minimize human error
- d. **Why we don't:**
Only capable of small-scale production
Have to custom build each table (not available in the mkt)

2. Full Sheet Laminator Pages

- e. **Features:** could potentially also utilize table system, would make a marked frame to lay sheet on top of made of metal, use magnets
- f. **Additional Features:**
- g. **Why we like it:**
Increased production efficiency by potentially making 9 cards at once
Could use the glue dots system to hold cards in place
Utilizing more of the laminator ability
Minimize human error
- h. **Why we don't:**
Hard to reach inside row of cards without wasting lots of paper
Could be more timely than single card production
Still tricky to get indicator strip to stay in place
Not rounded edges, different look (could be a pro)

4. Conclusions: What works well or does not. How it relates to prior art.



a.

4.1 Successful Ideas

- Indicator strip cutter- except needs a feeder (roller) adaption
- 12 business cards on one large sheet of laminate
- Sticky adhesive to hold cards/strips in place (Double Sided, n.d.)

4.2 Not-So Successful Ideas

- Building custom hole punch
- Finding hand punch to make cards one at a time with business card sleeves

4.3 Prior Art

Humidity Indicator Cards (HIC) used to track moisture levels in shipping containers of electronics.

Black circle surrounding the salt patch: (Humidity Indicator Cards, n.d.)

- we are hypothesizing serves as a waterproof seal or barrier between salts and paper card
- Help to build contrast between white card and salt patch



We researched current methods other producers are using to make a similar product or even copy a specific process, for example laminating or making a premarked template for card cutouts. Average price for 125 pk of HIC which can read RH at 10-20-30% = \$21.96 or about \$.18 per card (without shipping or handling), more expensive than we plan on making the Drycard. (Inc, D., n.d.) & (Temperature Solutions, n.d.)

*Image: <http://www.radiant.su/files/images/advantek/T-10030-1-HIC-Card-030925-new.pdf>

4.4 Economic Analysis

Assumptions:

- Prices are for bulk order to make 10,000 qty of dry cards
- Earmarked prices are not accurate. Need to obtain formal wholesale pricing from merchant.
- Prices below are overstated. Many items are priced at retail MSRP.

Overhead Costs

Item	Price	Unit
Die Cut Punch	\$40	each
Laminating Machine	\$80	each
Cutting Mat (Template)	\$7*	12 x 8 inches
Wood and Screws	TBA	-
Magnets	\$4*	4ft
Paper Cutter	\$30	each
Total	\$161	

Variable Costs

Item	Price	Unit
*Business Card	\$0.03	card
Laminating paper	\$0.03*	3.5 x 2 inches
CoCl ₂ Strip	\$0.0005	1.25 inch
Craftbond Tape Runner	\$0.004*	4 dots
Total	\$0.0645	<i>Finished product</i>

* according to VistaPrint.com

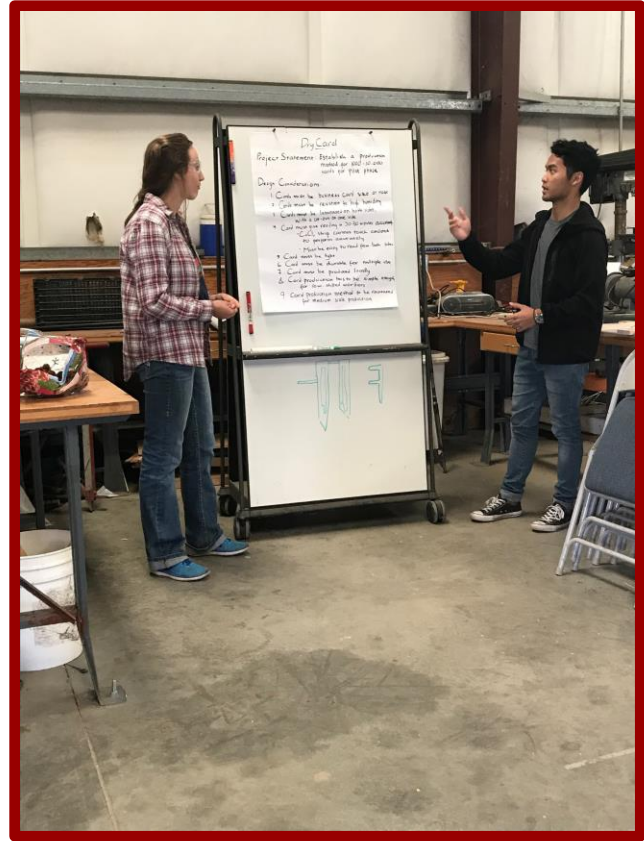
5. Recommendations: Specific Next Steps

5.1 In-Progress Ideas

- Plastic cards- laminate on one side
- Ordering business cards with hole already punched
- Make own custom jig/die-cut for hole
- How to set up materials to be sourced in identified developing countries

5.2 Future Work

- Test pressure adhesive laminate and cold setting on laminator
- Test different types of laminate paper
- Source materials as by-products from another process
- Add scent to card which attracts insects within storage bag
- Specialize card for specific commodity
- Create two cards- one with a yes or no (below or above 65%) and one with more detailed range of percentages



6. Bibliography:

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7. Appendix: Design Notebook Documents (*Deliverables*)

Design Notebook Deliverables:

1. Introductions and Project Statement: Choosing a Project
2. Initial Design Brief
3. Expanding the Design Brief and Brainstorm Project Considerations

4. Specific Design Criteria & Metrics
5. Brainstorming for Design Concepts
6. Proposed Design Concepts, Idea Evaluation, Project Timeline & Budget
7. Prior Art Survey
8. Design Review-
9. Not Included- Prototype Demo Presented in Class
10. Prototype Evaluation
11. 2nd Prototype Demo & Evaluation
12. Prototype Reviews