

**Lessons Learned from and for
Requirements Engineering and
Building Construction:
A Case Study of Requirements
Engineering for a Synagogue Kitchen
with Use Cases and Scenarios**

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Joint Work

with

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Vocabulary

UCs use cases

UCaSs use cases and scenarios

RE guess what

AEC Architecture, Engineering,
and Construction

Brief Lesson on Kashrut

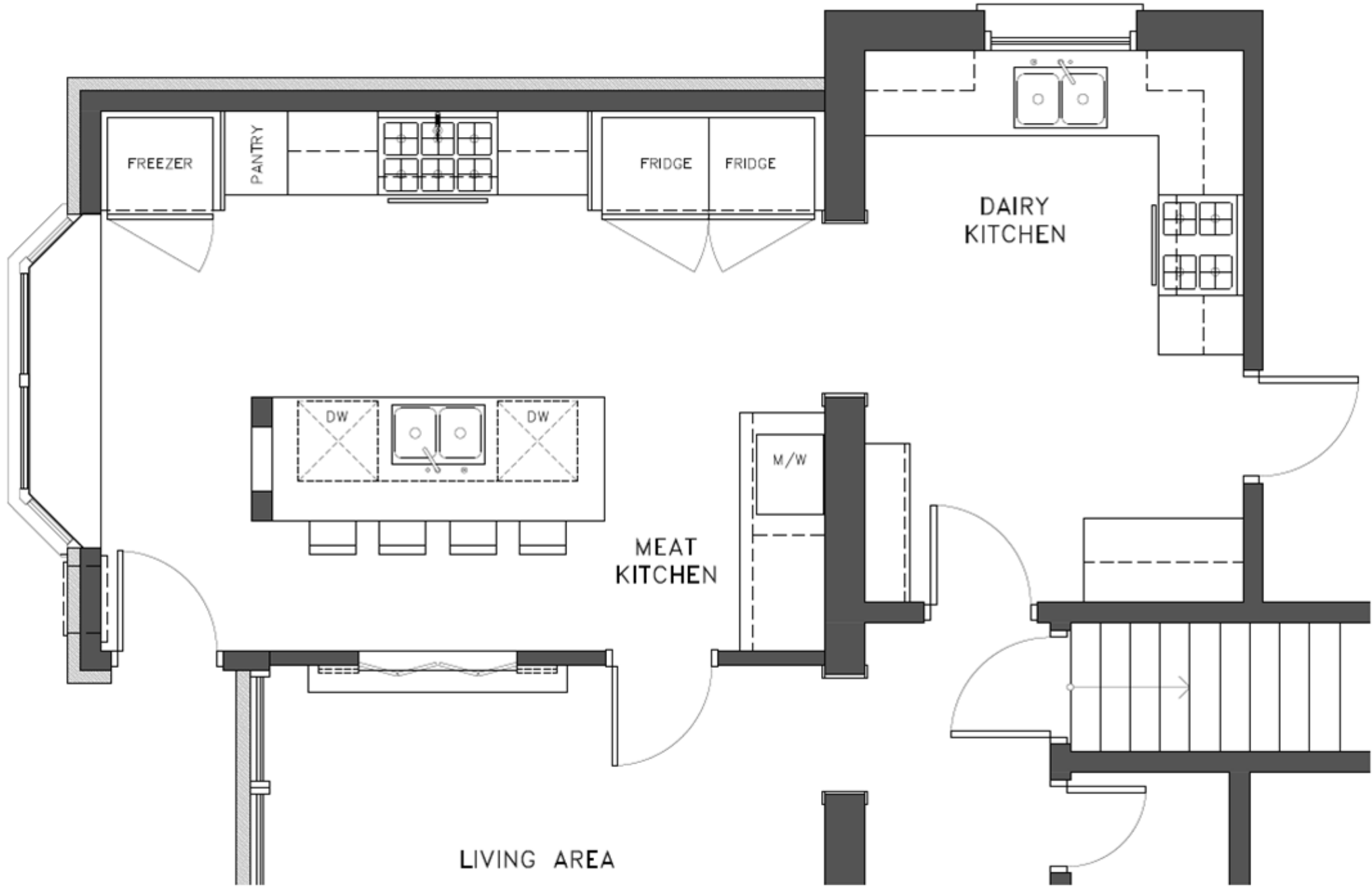
To understand this talk, here's what you need to know about kashrut, the property of being kosher:

- **Buy only fresh fruits and vegetables, and among all other food, only that certified as kosher, with e.g., “U”**
- **While preparing, cooking, eating, and cleaning up, keep meat and dairy foods separate.**

Kitchen Plans Sent by A Rabbi

A local rabbi sent me e-mail containing a complete set of plans for a new, necessarily kosher kitchen for the synagogue in which he officiated.

The kitchen was shared by the synagogue and the living quarters for the Rabbi, his wife, and their children.



Made an Appointment

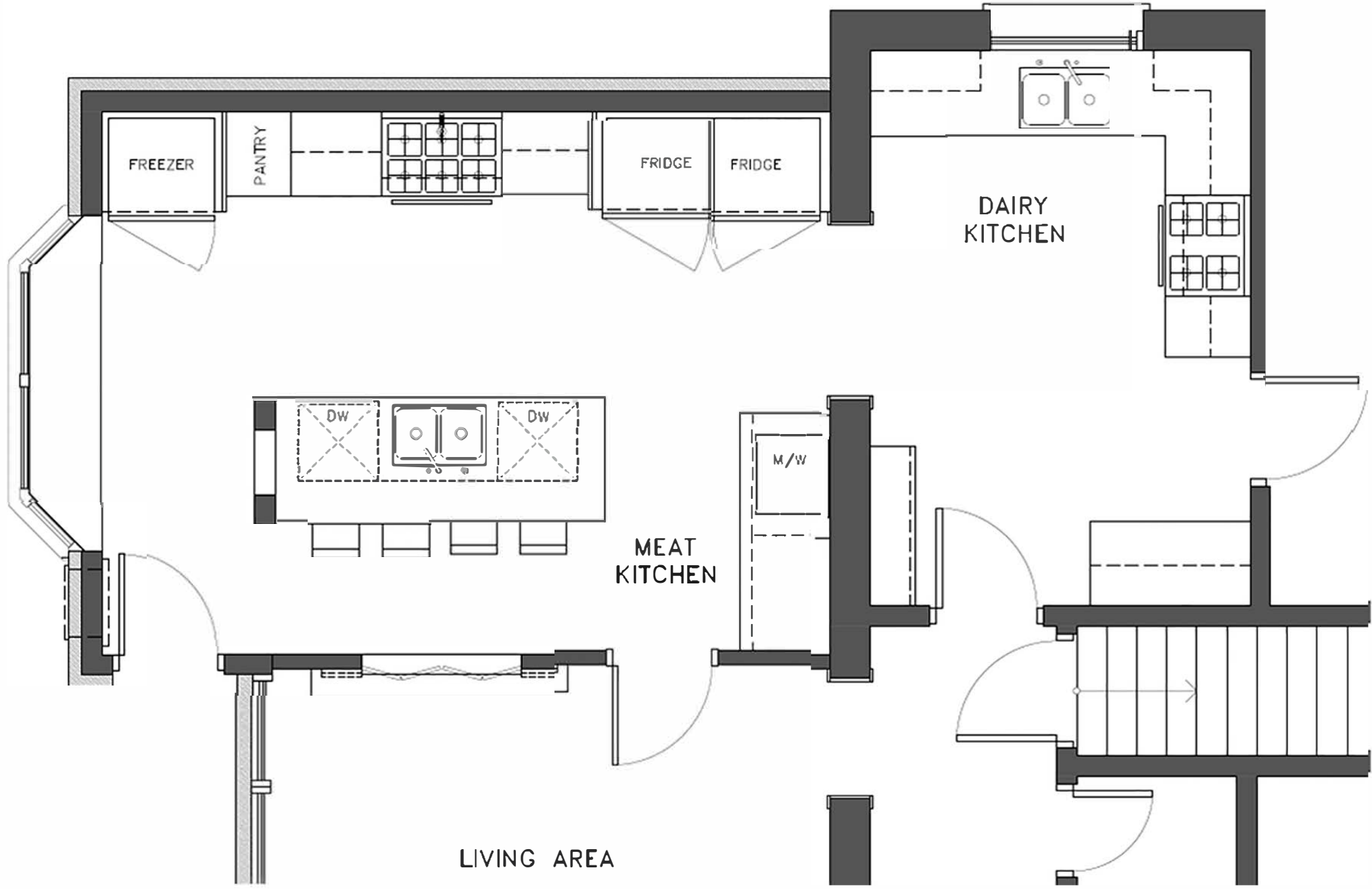
The Rabbi requested and got an appointment with me the next day, in my office to talk about the plans.

He did not say why he wanted to meet, and I did not ask.

My Reaction

**As an expert cook who ...
has catered two weddings, ...
has used dozens of poorly designed kitchens,
...
has designed a dream kitchen for his own
house, and ...
used to keep kashrut (eat only kosher food), ...**

I was bothered by the floor plan.



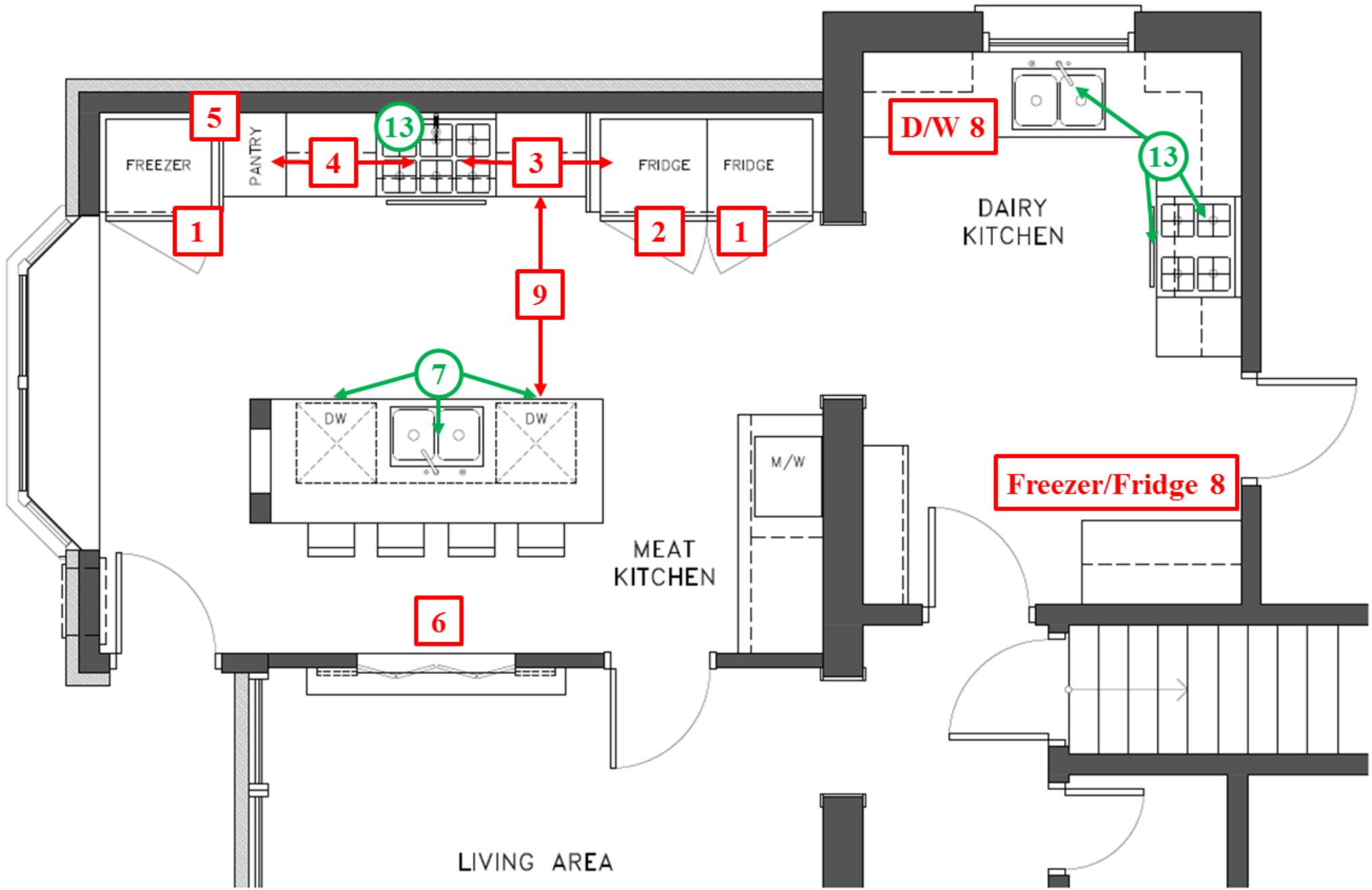
Temporal vs Spatial Separation of Meat and Dairy

**If you have one kitchen, as in most homes,
must have temporal separation:**

At any instant, kitchen is Meat XOR Dairy.

Clean up kitchen to switch.

**If you have complete spatial separation,
there's no need for temporal separation.**

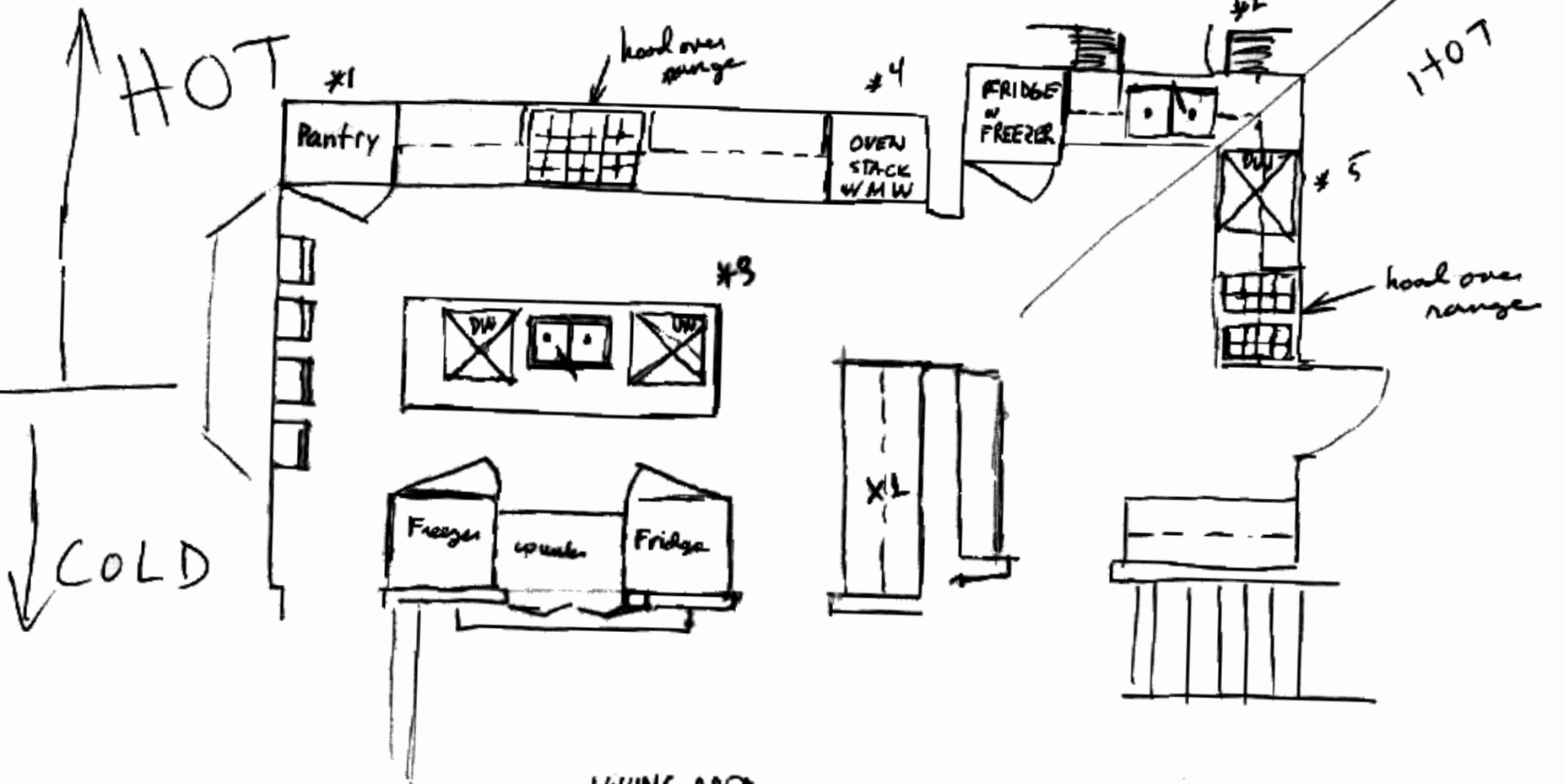


Reorganized Kitchen

I sat down and drew by hand what I thought was a better plan before the meeting with the Rabbi the next day.

All cabinets Full to Ceiling!

All things with doors, eg Fridge, Freezer, Pantry must have counter next to it on open side of door if it opens horizontally



#4 stack of ovens including M/W - need more ovens to cook things at different temperatures

#5 a missing DW!

LIVING AREA

#1 Larger Pantry!

#2 move window to right

#3 Move central counter towards range for more counter near service hole

Visit by the Rabbi

When the Rabbi came, I asked him, “Why did you send me the plans?”

He said that he was seeking a donation to fund the building of the kitchen.

“Ah”, I said.

I politely declined, saying that all my synagogue-targeted funds go to the synagogue of which I am a lay leader.

Surprised!

I had not guessed that this was his reason.

I told him that I thought that he had heard about my cooking expertise and my experiences in designing kitchens and therefore wanted my critique of the plans.

😊 /2

He said, “That’s a stretch!” 😊

Critique

I asked him if he would like to hear what I observed about the plans.

He said, “Sure, why not?”

Walk Through the Plans

I finger walked through the original and new plans guided by UCaaS, including coming home from shopping and preparing, cooking, and serving food, ...

to show what was good and bad about the original plans and why I made the changes I did.

Basically, I did with him what I did with you a few slides ago.

The Conversation

The Rabbi protested that his wife, not he, does these activities.

I told him to use his imagination.

He did and followed me.

Downstream Costs

I told the Rabbi that if he built the kitchen as planned by his architect, they would discover all these problems later.

They would end up modifying the kitchen close to my plan.

The cost to fix these problems later would be at least \$20K.

My Donation

“There’s my donation!” I said. 😊

I added that in *all seriousness* I had saved the synagogue \$20K or more by discovering these problems now before the kitchen is built.”

Problems with My Plan

During the walkthrough with the UCaSs, I noticed some flaws in my plan:

- **The pantry is still too close to the stove.**
- **The dairy kitchen has no pantry for storage of dairy items.**

Towards a Better Plan

I decided to make full lists of UCaSs and principles ...

to develop a better plan.

Scenarios:

- A. coming home from shopping and putting food away in refrigerator
- B. coming home from shopping and putting food away in freezer
- C. coming home from shopping and putting food away in pantry
- D. coming home from shopping and putting food away in cupboard

- E. removing food from refrigerator in preparation for cooking
- F. removing food from freezer in preparation for cooking
- G. removing food from pantry in preparation for cooking
- H. removing food from cupboard in preparation for cooking

- I. removing dishes from cupboard and taking them to dining room

- J. preparing to cook and cooking a meat meal
- K. preparing to cook and cooking a dairy meal

L. adding water to pot that is being cooked

M. removing hot item from oven

N. removing hot item from range

O. removing hot item from microwave oven

P. taking food to dining room

Q. getting rid of garbage

R. getting rid of compostables

S. getting rid of recyclables

T. washing dishes in sink

U. washing dishes in dishwasher

V. removing dried dishes from dishrack and putting them away

W. removing dried dishes from dishwasher and putting them away

These scenarios lead to some principles, particularly, 1, 2, 7.

Kitchen Principles, Including for Kashrut:

1. There should be a counter top next to or very near anything that opens or is hot, e.g., a refrigerator, a freezer, a pantry, a cupboard, a dishwasher, an oven, a range (so that one does not have to hold any item take from the anything or put it on the floor).
2. For anything that has a door with vertically placed hinges, there should be a counter on the side not having the hinges, so that moving items to and from the thing from and to the counter does not have to go around the thing's door.
3. Separate hot things from cold things, e.g., an oven from a freezer.

4. Separate hot things from room-temperature things, e.g., an oven from a pantry.

5. Separate cold things from room-temperature things, e.g., a freezer from a pantry (because the exhaust of a cold thing is warm).

6. Divide the kitchen into three regions, hot, cold, room temperature. Each region should be contiguous.

7. A dishwasher should be adjacent to a sink.

8. If you have separate kitchens for meat and dairy, each should be at least minimally functionally complete, i.e., one should not have to go over to the other kitchen to do any part of a job being done in one kitchen.

9. One never has too much counter space.
10. One never has too much cupboard space.
11. One never has too much pantry space.
12. The counter next to a hot thing should have a burn-resistant top.
13. Adding water to someone on the range or in the over should not require carrying water or a pot over a floor. (The carrying, if any, should be over counter tops.)
14. Cabinets should all the way to the ceiling to get some dust-free storage for very low frequency items, to take advantage of the space to the high ceiling, to avoid dust-trapping space between the tops of cabinets and the ceiling, and to avoid building a useless hollow filler between the tops of cabinets and the ceiling.

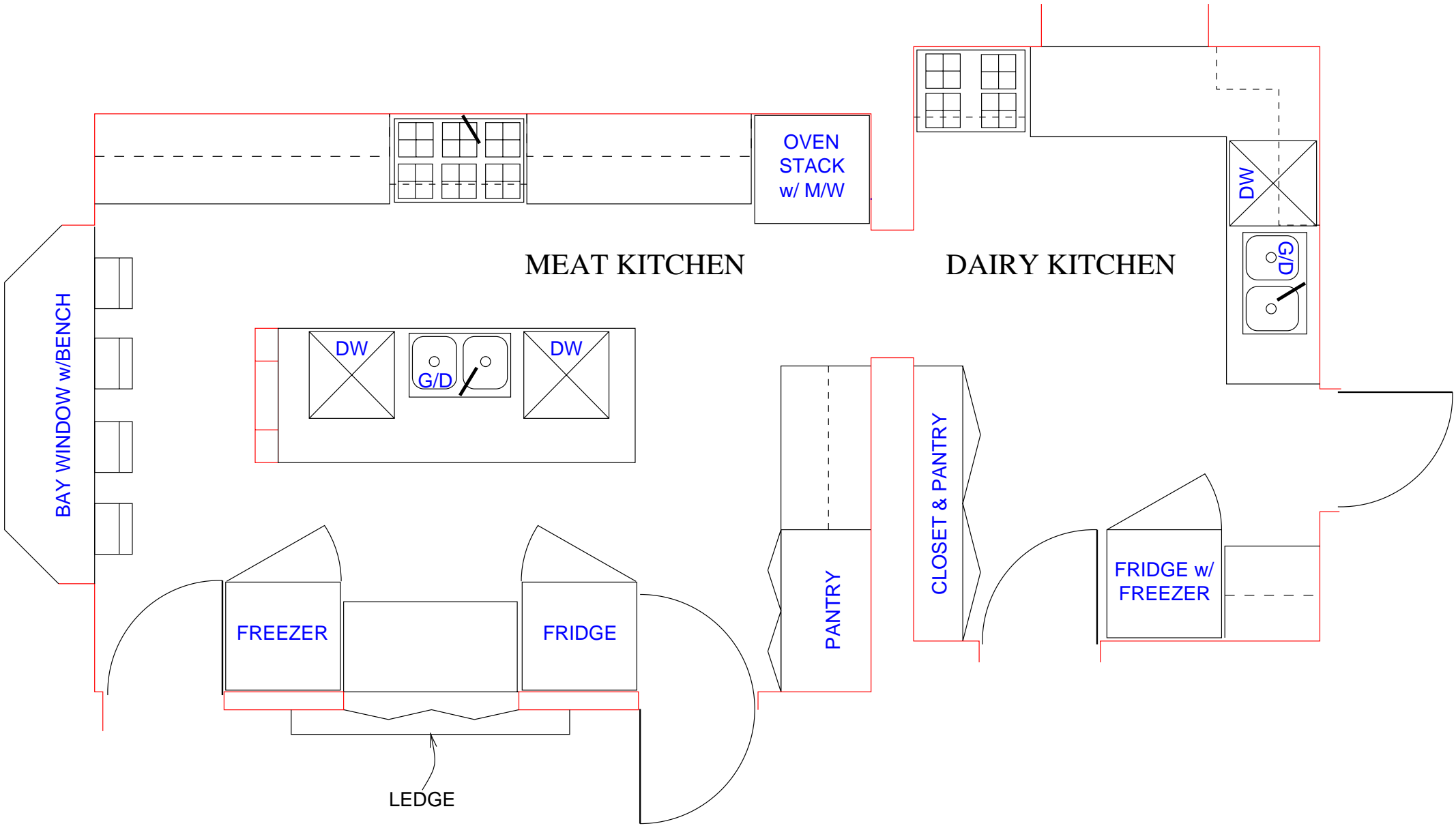
Kitchen Domain

The kitchen domain is well understood:

There is even a book, *Household Engineering: Scientific Management in the Home* by Christine Frederick, published in 1919 that lists UCaSs.

New Plan

So I worked for another week, improving my plan and sent the final result by e-mail to the Rabbi.



BAY WINDOW w/BENCH

MEAT KITCHEN

DAIRY KITCHEN

OVEN STACK w/ M/W

FREEZER

FRIDGE

PANTRY

CLOSET & PANTRY

FRIDGE w/ FREEZER

DW

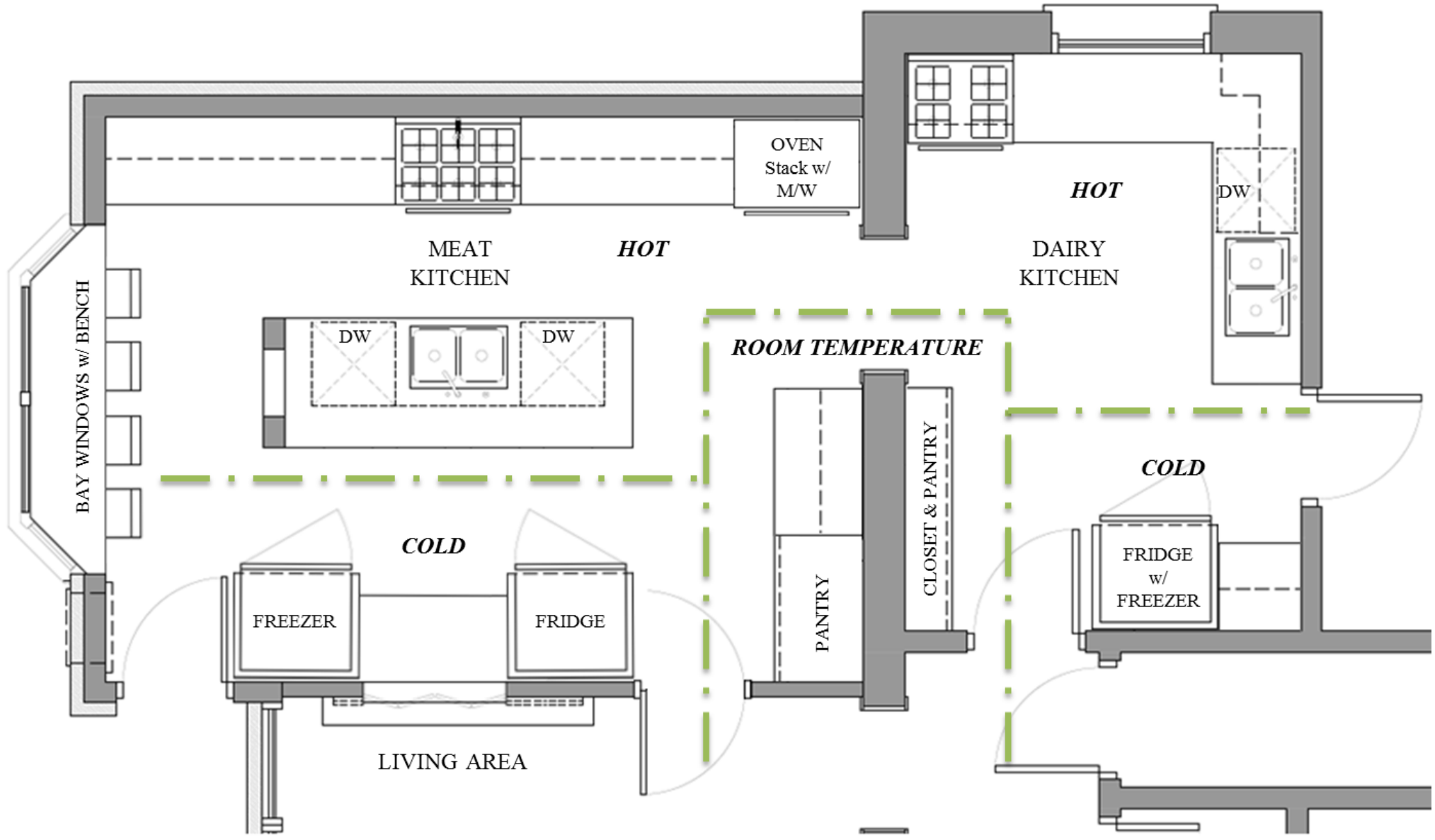
G/D

DW

DW

G/D

LEDGE



BAY WINDOWS w/ BENCH

MEAT KITCHEN

HOT

OVEN
Stack w/
M/W

HOT

DAIRY
KITCHEN

DW

DW

DW

ROOM TEMPERATURE

COLD

FREEZER

FRIDGE

PANTRY

CLOSET & PANTRY

FRIDGE
w/
FREEZER

LIVING AREA

The Rabbi's Decision

The Rabbi decided to go with the original plan, because that's what his wife wants.

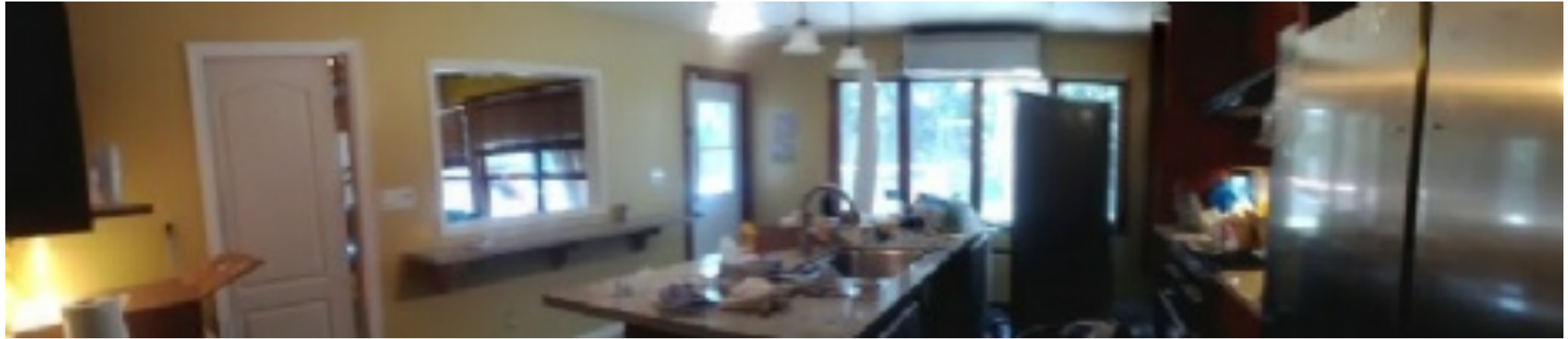
I offered to meet with his wife and architect to show them my observations, ...

but he declined. ☹️

Two Years Later

The kitchen is built already.

The next slide shows a photo the Rabbi took and posted at the synagogue's Web site.



The Picture Shows

The picture shows the central island closer to one wall than to the other and ...

the hinge at the top of the door of one of the refrigerators, ...

so the doors open as in the plan.

Why, Oh Why?

Why did the Rabbi stick with the original plan?

Wer weis?

Clearly some emotional issues here.

What Happened with Architect?

I asked the Rabbi if the professional architect had done what I did?

Reply: “No!”



No Serious RE

No serious requirements analysis

with full set of UCaaS!!!



Asked Architects

I asked a few professional architects and architecture students if they learned what we call RE in architecture school.

All replies: “No!”



Even at CMU

CMU's School of Architecture has an RE course derived from the MSE program's RE course.

But, it's for a special program about SW tools for architects to use.

It's *not* a required course for all architects.

Programming

Architects call RE “programming”!

And it’s left to junior architects to reserve the real architecture work to the senior architects, i.e., designing beautiful buildings that wow customers.

Parallel in SE

Hmm! what SE calls “programming” is considered unglamorous ...

while designing architectures is considered glamorous. 😊

A Theory

Based on my past experience with house building and remodeling, anecdotes told to me by friends and relatives, and discussions with Cyril Mauger and Eric Dubois at CRP Henri Tudor in Luxembourg, ...

Mauger, Dubois, and I describe the business model of building architects and contractors:

Construction Business Model

To make the plans that are used in the construction, do just enough RE to make the customer happy that he or she has received good service, ...

but not enough that he or she discovers the *real* requirements and *all* the problems with the delivered plans.

Underbid on the initial construction to win the customer.

Business Model, Cont'd

Agree to impossible deadline.

The contract might even specify penalties for late completion, but cancels them if customer makes changes.

Customer discovers real requirements and problems with the plans during construction.

Customer *demand*s changes.

Business Model, Cont'd

Adapting to new requirements and fixing problems is *much more expensive per square meter* than in contract.

All penalties are off.

Kahneman Agrees

Daniel Kahneman in his *Thinking, Fast and Slow* documents and explains this phenomenon on page 250 and 251.

But If RE is Complete

Plans meet customer's real requirements and have no problems.

Customer *never* requests changes.

Contractor is stuck with original price and impossible deadline.

Contractor loses money on building.

Contractor might even go bankrupt.

Research is Continuing

Mauger, Dubois, and I are continuing research aimed at motivating:

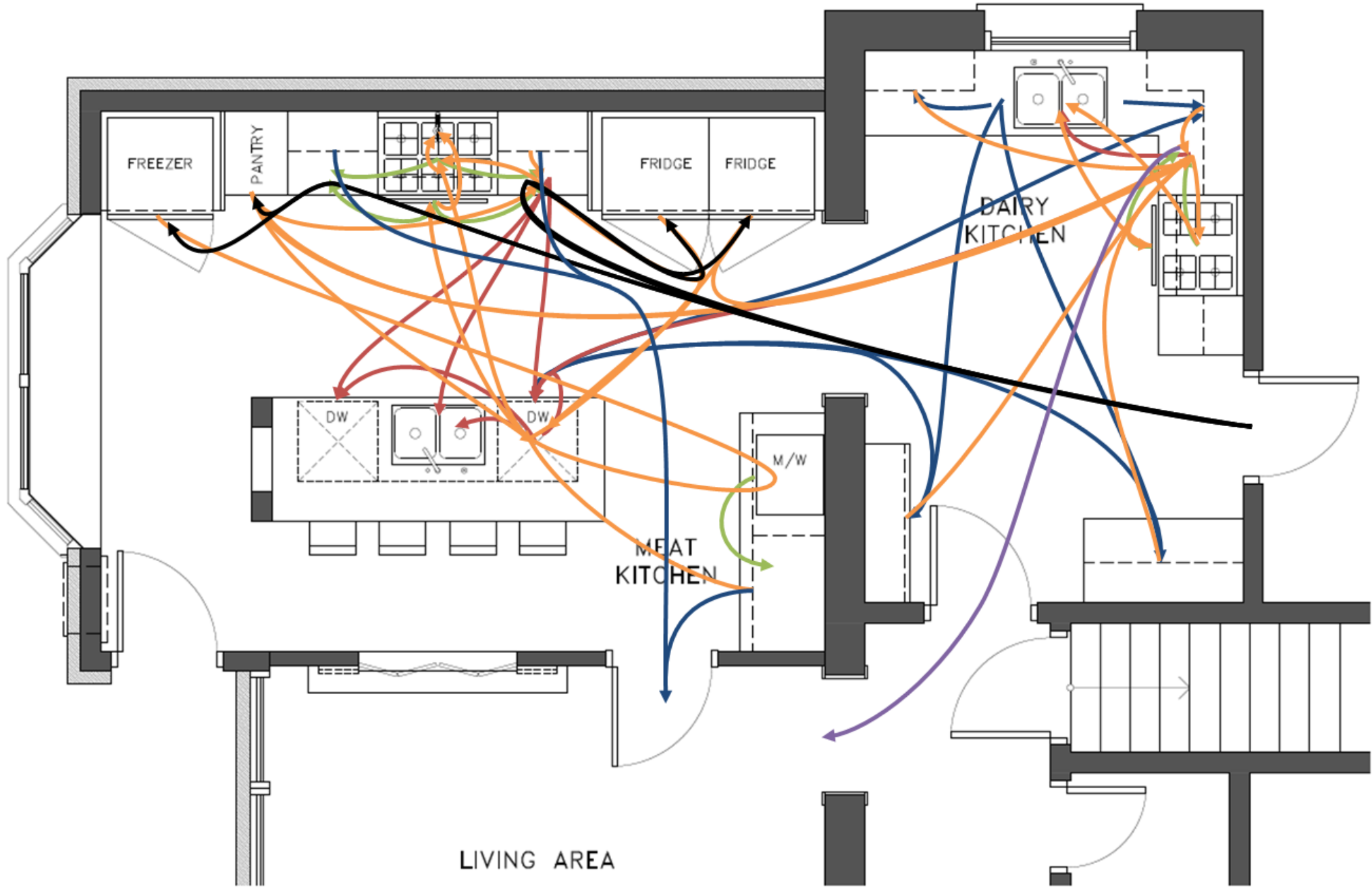
changing building construction so that its RE is thorough and its bidding is accurate.

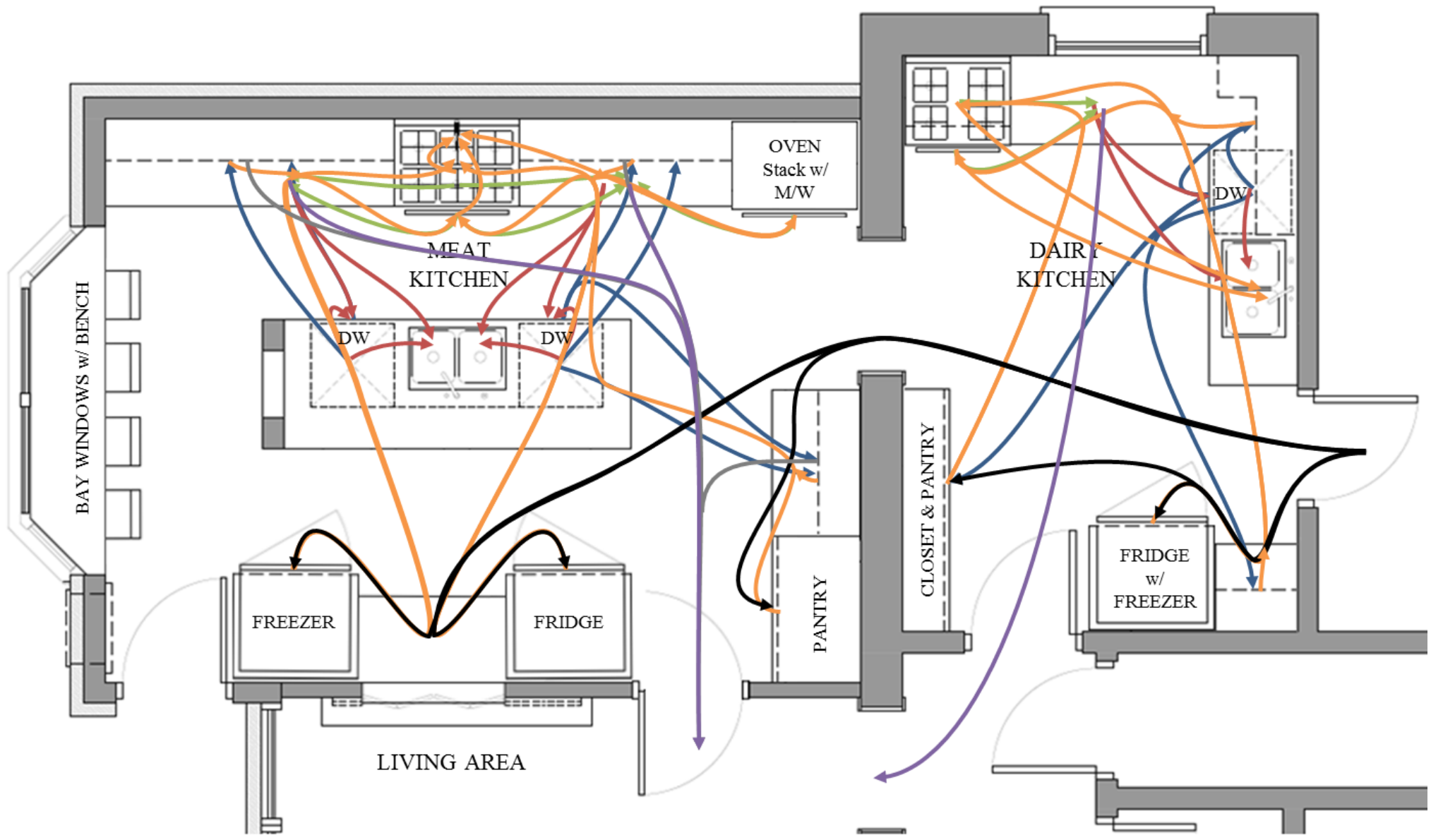
changing software development so that it's like the changed building construction, i.e., with thorough RE, accurate bidding, ... *and* changes after RE is done cost \$\$\$s.

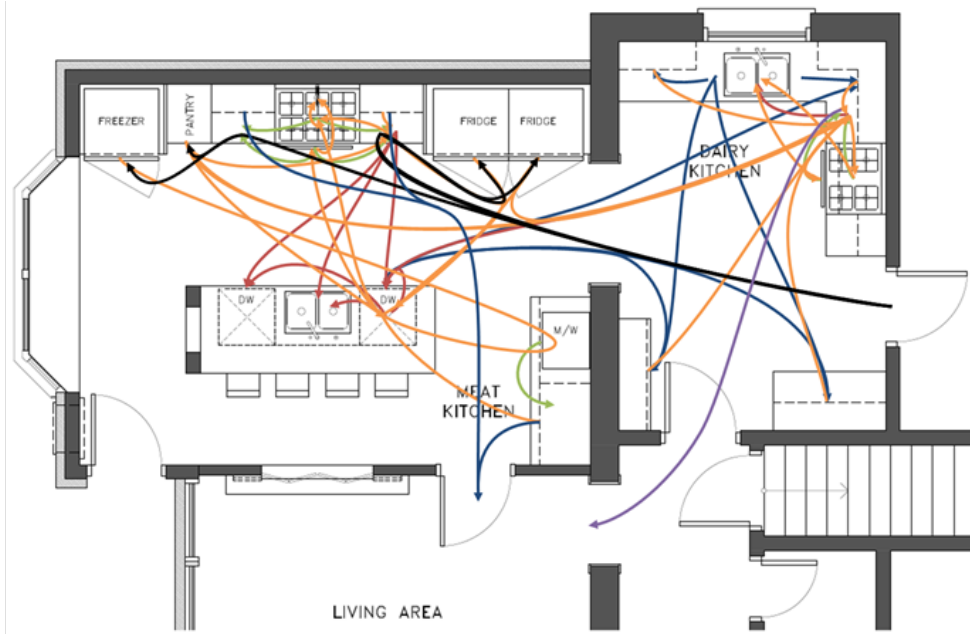
Mauger's PhD Research

Mauger is exploring the issues raised by this case study.

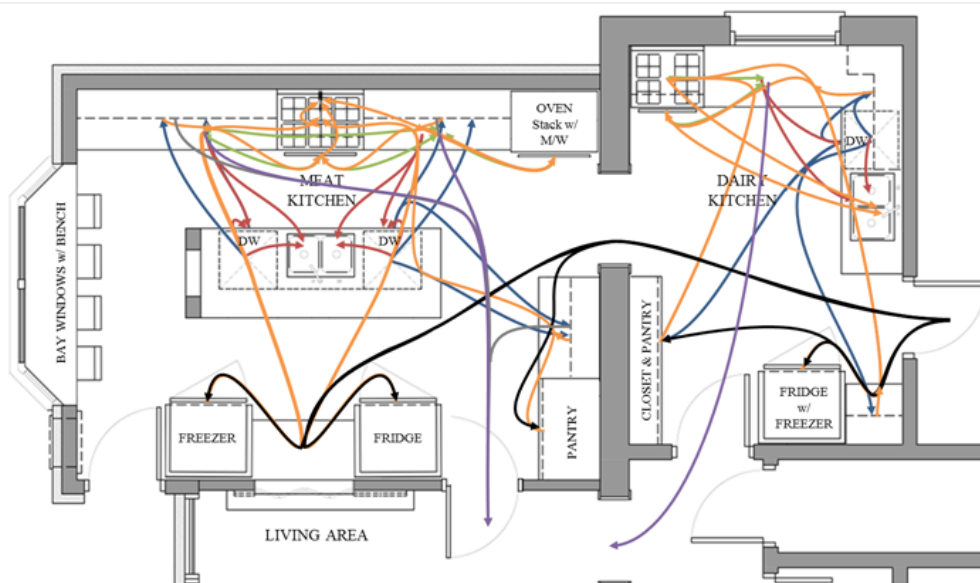
He is also developing some tools to help do the UCaS analysis of building plans.







a. Original plan of the kitchen by the architect.



b. Modified plan of the kitchen by Berry.

Black lines:

- A. coming home from shopping and putting food away in refrigerator
- B. coming home from shopping and putting food away in freezer
- C. coming home from shopping and putting food away in pantry
- D. coming home from shopping and putting food away in cupboard

Orange lines:

- E. removing food from refrigerator in preparation for cooking
- F. removing food from freezer in preparation for cooking
- G. removing food from pantry in preparation for cooking
- H. removing food from cupboard in preparation for cooking

Grey lines:

- I. removing dishes from cupboard and taking them to dining room

Orange lines:

- J. preparing to cook and cooking a meat meal
- K. preparing to cook and cooking a dairy meal
- L. adding water to pot that is being cooked

Green lines:

- M. removing hot item from oven
- N. removing hot item from range
- O. removing hot item from microwave oven

Purple lines:

- P. taking food to dining room

Red lines:

- T. washing dishes in sink
- U. washing dishes in dishwasher

Blue lines:

- V. removing dried dishes from dishrack and putting them away
- W. removing dried dishes from dishwasher and putting them away

Open Questions

- **How exhaustive is the set of kitchen use cases?**
- **What set of tools are necessary to be able to do a large building what I did manually for one kitchen?**
- **Can software engineering learn anything from AEC?**

Open Questions, Cont'd

- **Did I illegitimately try to impose *my* requirements on the Rabbi?**
- **Why did the Rabbi stick with the original plan?**
- **Why did the Rabbi not go with my plan?**
- **Why did not the professional architect do a thorough job of programming (i.e., requirements analysis)?**

Lessons Learned

- **Techniques that work for RE of SW systems seem to work also for AEC.**
- **The AEC trade can learn about programming from the RE field.**
- **The SE trade can learn about charging \$\$\$\$s for changes to requirements from the AEC trade.**

Lessons Learned, Cont'd

- **Even when functional requirements should dominate a client's decisions, emotional issues may cropping up.**
- **The education of the typical AEC architect seems to be lacking a course in programming, programming techniques such as UCaSs, and interacting with clients.**