

“Making Plastic Foundation Work for You (and your bees)”

an e-book by
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Summary: Plastic foundation seems to be gaining popularity among beekeepers over conventional wax foundation. More and more supply catalogs are offering plastic foundation, and suppliers continue to offer more and more selections of plastic products.

Several common advantages with plastic foundation include reduced labor (no wiring or supports needed, and in some cases, no assembly required), wax moths and mice cannot damage plastic foundation, plastic foundation has greater strength to hold up to the extraction process, and there is a greater opportunity to scrape the plastic foundation and reuse it all over again.

However, plastic foundation suffers from a reduced acceptance rate with the bees when compared to conventional wood-frames with crimp-wired, wax foundation. Reduced acceptance of plastic leads to poor hive production and increased beekeeper frustration.

The purpose of this manuscript is to present information and methods that will increase and accelerate the acceptance of plastic foundation, in order that both bees and beekeepers may benefit from the advantages that plastic foundation offers.

Humanity adores the power of choice. My teenage children are convinced my childhood was irreparably impaired because I grew up with only three channels on our black and white television.

Today, with the offerings on the cable and satellite dish, my children seem to spend more time flipping through channels with the remote than actually settling down on a program to watch. After spending twenty minutes flipping around the 659 channels from our cable subscriber, they complain there's nothing on, then, at the top of the hour with the new selection of programs, they repeat the same process.

Sometimes making a choice is overwhelming.

Beekeepers also have choices. We can choose to run 8-frame mediums or full-depth brood boxes. We can feed High Fructose Corn Syrup or mix up our own sucrose syrup in a variety of strengths. There are several different races of bees from which to choose and we sometimes develop some rather peculiar reasons for making our choices. And once those choices are made, we often become rather obstinately opinionated in defending our choices.

One of the most significant developments in the history of beekeeping is the moveable, wooden frame fitted with embossed sheets of wire-reinforced beeswax. For several decades, this was the conventional method of coaxing bees to build straight combs to maximize the number of worker cells. Wires were embedded to give additional strength and support. Wood frames were also cross-wired to give the wax foundation added strength.

This was pretty much the only choice a beekeeper had to utilize moveable frames in the “modern” beehive.

In the last couple of decades, changes in the manufacturing technology have brought forth a variety of choices when it comes to frames and foundations. Plastic foundation has replaced embossed wax sheets to fit wood frames, replacing the wax foundation. And one-piece units of molded plastic incorporate both the plastic foundation and a plastic frame together. These are generically referred to as “Pierco-style” frames, named for one of the earlier companies that produced these one-piece units.

Today, there are several manufacturers of different one-piece units incorporating both the frame/foundation constructed entirely out of plastic, and then there are likewise several manufacturers who also make sheets of embossed plastic to slide into wood frames.

Then there’s Duragilt, a modified plastic foundation which I will largely ignore in this manuscript because I’ve found it to be just as acceptable as the old-fashioned, crimp-wired, wax foundation. It’s great, except when the bees eat the wax off the plastic base during a nectar dearth, or the wax coating falls off the plastic core/base during cold weather or rough installation.

Then the bees will not replace it. You’ll have a horrible, permanent bald spot on your foundation. The bees will not replace the lost wax and recoat the plastic base. Other than this one flaw, Duragilt is great and easily

utilized by the bees. It has great strength in the extractor. It is easy to install and does not need additional wires to reinforce the wax.

Today you can even purchase the equivalent of fully draw comb in a plastic frame under the names of "Honey Super Cell" and "Permacomb."

You can order plastic frames/foundation in different sizes, such as the "small cell (4.9mm)" and drone-sized cells to assist your mite-trapping, drone-removal IPM (Integrated Pest Management).

Today's Issue of Plastic Foundation

The shift from wood/wax to plastic is all about convenience and saving time and labor. Ask anyone who has spent an evening assembling wood frames, tying wires, inserting wax foundation, then embedding the wires. While it's not particularly back-breaking work, it is tedious and time consuming.

Wax foundation cannot be shipped when the weather is cold because the cold makes the wax extremely brittle and fragile. However, my best time to assemble wood/wax frames is in the winter so I need to make sure I've got enough wax foundation on hand before winter sets in. My biggest complaint about assembling these frames is how time consuming it is.

Plastic foundation is all about making my life easier as a beekeeper. Unfortunately, the bees don't seem to see it that way! If given a choice, the bees will always choose frames with wax foundation over frames with plastic foundation (although the bees seem to favor wood frames with plastic foundation over the all-in-one plastic frame/foundation).

A Caveat About Plastic Foundation

However, given the bees' preference for the naturalness of wax and the beekeepers' affinity for the convenience of plastic, **I cannot emphasize enough that plastic foundation cannot be managed in the same way as wax foundation.** I've heard from a lot of beekeepers who said they placed a super or brood box of plastic foundation on top of their hive and the bees totally ignored it. And I don't question that statement one bit. It's happened to me.

Or perhaps you know the beekeeper who put frames of both wax and plastic foundation in the same hive body and the bees worked the wax and ignored the plastic. Yep, I've done that too.

Others have told me they put plastic frames/foundation in the brood box and the bees refused to draw out those new frames. Upon further inspection, they said they found swarm cells. Then they blamed the plastic foundation on causing the colony to swarm! And to add insult to injury, a swarmed colony has a reduced workforce and it will not draw out plastic foundation.

Plastic foundation is not for the timid beekeeper or the lazy "bee-haver" (to borrow moniker from the late, George Imirie, 1923-2007). To make plastic work, you have to be involved with your bees. **Plastic foundation requires better management than wax foundation**, but I also believe that the extra management is not beyond the average person's grasp. I think there are more lazy beekeepers than ignorant beekeepers out there in the world. Don't let someone else's failure intimidate you. Plastic foundation can, and does, work. But you're going to have to work at it.

For all the complaints about how plastic foundation doesn't work, there are a host of beekeepers who wouldn't go back to wax foundation for the honey in China. But let me warn you, you can't approach plastic foundation in the same manner as wax foundation. So how do you approach plastic foundation to gain the bees' confidence that plastic will work? That's what this manuscript is all about.

A Caveat From the Bees

For all the benefits and advantages that plastic foundation offers, bees are reluctant, if not downright balky about accepting plastic foundation. Their resistance creates frustration in the life of the beekeeper, and it isn't long before the beekeeper doesn't think much of plastic foundation either!

I sometimes imagine a beekeeper and a honeybee sitting across from one another at a table. The beekeeper pushes a frame of plastic foundation toward the bee and authoritatively commands, "You will draw this out."

"Oh, no I won't," responds the bee as she pushes it right back across the table.

“Oh, yes you will,” the beekeeper commands and the frame of plastic foundation is again thrust toward the bee.

“Oh, no I won’t,” she protests as she pushes it right back at the beekeeper.

“You will.”

“I won’t.”

“Will!”

“Won’t”

So who is going to win this argument? Neither, really. I imagine the beekeeper placing all plastic foundation in the hive and demanding, “You will draw out this plastic foundation and until you do, there will be no pollen for dessert!”

That was the similar argument my mother had with my finicky younger brother. She insisted he eat his vegetables. She threatened him by taking away his television privileges. She forced him to sit at the table until he ate his vegetables. He wouldn’t budge and she wouldn’t give in. There were many nights that he fell asleep at the kitchen table, his vegetables left untouched. It was the battle of the human will. So who won? Neither, really.

While I don’t think things are this extreme in the beehive, I can imagine a beekeeper shouting at the bees, “You will draw out this plastic foundation!”

And the bees simply staring back, “You can’t make us, punk. Go ahead. Make our day!”

I think the worst thing with plastic foundation is that the bees simply do not share the beekeeper’s fascination and enthusiasm for plastic foundation. And once suitably frustrated, the beekeeper also loses interest. Sadly, both the beekeeper and the bees suffer. Neither wins.

I always thought there was supposed to be a better way. Manufacturers don’t spend millions of dollars producing and advertising a product that just won’t work. Somewhere, someone had enough success to

believe plastic foundation had a niche in modern beekeeping. And I believe it does. That's what this manuscript is about.

Developing a Vision for Plastic Foundation

In the 1967 movie, *The Graduate*, Dustin Hoffman plays a somewhat uninspired, recent college graduate, Benjamin Braddock. At a pool party given by his parents, one of the adult guests pulls Benjamin aside and gives him an inside tip that the future is, in one word, "Plastics." This word is, perhaps, one of the more memorable lines from the whole movie.

That word has an increasing significance with modern beekeeping practices. The popularity of the conventional wood frame and crimp-wired, wax foundation is giving way to the ease and convenience of plastic foundation. And make no mistake about this: I greatly appreciate anything that will make my life easier! But convincing the bees to accept plastic foundation is anything but easy.

Despite my flowery, unadulterated adulations of plastic foundation, my bees hold a contrary position. They just don't welcome plastic foundation with a grand enthusiasm. If anything, they seem to resent my modern, futuristic thinking. They resist drawing out plastic foundation as if it were a "foreign" object.

Okay, they got me on that point. It's very much a foreign object. No wonder they seem to hate it with a passion.

And don't get me wrong. I like wood frames with wax foundation. I find nothing more relaxing than spending winter months assembling frames while watching NFL football on a Sunday afternoon. I even enjoy doing it on Sunday nights and Monday nights. I don't feel so guilty watching football because I'm multitasking. But it takes a lot of time to assemble those frames.

If I kept only a few hives, assembling and wiring twenty or thirty wood frames would be no big deal. But with over a hundred colonies, I just don't have the time to assemble that kind of volume. Then there are the issues of the added strength, durability and the reusability of plastic foundation.

While I'm able to assemble a couple boxes of wood frames in the winter, time passes quickly and soon the springtime awakenings create a

seismic-level shift in my priorities. Now the convenience of plastic becomes a major factor in my hectic schedule. And besides, there's no football in the spring.

I find no greater joy than opening a carton of fresh, plastic frames and moving them from the shipping crate to a beehive with no assembling, no wires, no wax, no glue, no nail gun, no spousal complaint of, "Are you coming in for dinner or are you going to spend all night in the garage assembling those bee frames?"

Of course, the second-greatest joy is having the bees accept the plastic frames. And that's the real rub of plastic foundation.

Plastic is *NOT* Better Than Wax

I believe in plastic foundation. Before I show you my tricks and tips, let's think through this idea of why plastic is better than wax. Actually, that's really an inappropriate place to start. Plastic isn't better. I don't want to denigrate wax and brag on plastic as an "all-or-nothing" proposition. And don't mis-interpret my comments to think that I consider plastic the only way to go or the panacea for the progressive beekeeper.

Plastic isn't better; it's just different and both wax and plastic offer a host of different variables and options that may fit your management scheme and your skill levels. We're all different and we need to respect those opinions. We all keep bees in different locations with different weather patterns.

Let's look at the situation as why someone might consider plastic as an alternative to wax, and vice versa. And bear in mind, as all locations have different variables, certain factors may not be an issue for you. We all have our own opinions, even in the face of contradictory facts.

I'm also of the opinion that two rational, sane and intelligent people can hold opposing views and both possess an element of truth.

Don't hate me because I prefer plastic foundation. I still use wax foundation in a lot of my hives.

So here's why I like wax foundation set in wood frames:

Wood hive parts still have, and will likely continue to hold their place in the future of beekeeping, especially with the smaller beekeeper who has the time to assemble and wire wood frames. The biggest advantage I see with wood frames with wax foundation is their unconditional acceptance on the part of the bees. They draw it out every time.

Primarily, the bees readily accept wax foundation without any hesitation whatsoever. Put it in the hive and, "BAM!" They draw it out. If there is damage from a mouse eating a hole in the lower corner of the comb, the bees will repair it and fill in that void with fresh beeswax. It may be, however, depending upon the time of year, that the bees will fill in that void with drone comb, but that's another issue for another day.

There is also an intangible, nostalgic quality about the "naturalness" of wood and wax that supersedes the benefits of plastic. And while these frames take time and energy to assemble, and it is somewhat tedious and time consuming, if I'm not pressed for time, is kind of relaxing for me to put together wood frames. I like the smell of fresh wood and the way these specially-tooled pieces fit together.

But I just don't have that kind of time or sentimentality, and the challenges to my time schedule continue to draw me back to the convenience of plastic foundation.

Here are my concerns why I begin to shy away from wax foundation:

Primarily, it's the time and labor involved in assembling, wiring and inserting wax foundation into the wood frames that pulls me toward plastic. If I only had three hives, this would not be a major problem. But I have over one-hundred hives and I just don't have this kind of time to devote to assembling frames.

If I have a problem with wax moths, cleaning the frames is time consuming and mice will often chew the wood. I've thrown away frames because fixing them just takes more time than if I just bought new pieces to start with. Unless supported with wires, wax will sag and bow and many times the wires need to be replaced when you repair wood frames. And if you have to clean out old wax and hardened propolis, the old wires make it more difficult.

In the extractor, especially if you have a “tangential” extractor that requires you to reverse the frames, you have to be very careful or you'll have a “blow out.” This is especially true with newer drawn comb. “Radial” extractors are more kind to newly drawn wax, but you still have a potential for problems.

Unfortunately, wood frame components necessitate frequent replacement and almost always need to be purchased. Further, fixing and repairing is time consuming.

While the wood frame can be recycled and refitted with another sheet of wax foundation, I find it just takes too much time to prepare the wood to accept a new sheet of wax foundation. I still have to clean off the propolis, remove the wedge bar, clean out the bottom groove, and most times, add new horizontal wires. I'm better off buying new frames and starting from scratch. But then I also have the time-consuming chore of assembling the pieces when they arrive.

If anything, I find it much easier to crudely scrape the frame and insert a sheet of plastic foundation. The plastic foundation is more forgiving than wax and it takes less time to insert. I know some beekeepers who boil their old wax frames in lye to clean out all the old wax and propolis. This is an option I have not tried only because I've not invested in a pot big enough to boil frames.

So here's why I like plastic foundation, even the one-piece frame/foundation:

Primarily, it's opening a shipping carton and they are ready to go—no assembly required. These frames are strong and rigid and resist damage from mice and wax moths. If I do get wax moths, these plastic frames clean up quick and neatly. They can be reused without buying replacement parts. In the extractor they are indestructible.

Removing frames from the super is also easier with plastic, and in a well-propolized super, the effort to remove intractable wood frames, I have ripped the top bar from the rest of the frame, leaving the honeycomb stuck in the super. Then I have a mess and a broken frame.

Plastic foundation is becoming the cornerstone of my operation, and you'll probably notice an increasing offering of plastic hives, hive parts and frame components in all the major bee supply catalogs. The beauty of these

nearly indestructible items is they are usually constructed as one-piece units. They seldom come apart or crack. They never need painting and withstand a great deal of abuse, especially from the elements.

What I really love about plastic foundation is the permanency and reusability. Old plastic foundation can be scraped off, pressure washed and reused. This is especially easy if they've spent a night in the freezer, or if I attack this chore in January.

Secondly, what was especially true when I spun my honey in a 2-frame, tangential extractor, was the resiliency of plastic frames that prevented a "blow-out." With plastic foundation I find an unprecedented convenience and a savings of my time and energy.

Here are my concerns why I might shy away from plastic foundation:

The bees are often reluctant, frequently hesitant, and sometimes downright resistant toward accepting plastic foundation. This is my biggest complaint. The conditions have to be just right to draw out the foundation into comb. When given to weak hives, the hives just seem to grow weaker. Establishing a package on plastic is a recipe for disaster.

Further, when the bees do not like the plastic, they will build "bridge comb" perpendicular to the plastic foundation between each sheet. What a mess! These frames need to be removed and scraped and given another shot at being properly drawn out.

These plastic frames will also tend to slip when uncapping, and there are some mechanical uncappers in which plastic frames will bind, catch, then lurch loose and sometimes shoot out onto the floor. Yep, been-there, seen-that.

While welcomed initially by beekeepers for the promised labor-saving benefits, the relative permanency and the promise of reusability, the honeybees have been more than a little balky and reluctant (dare I say, "stubbornly resistant") to draw out plastic foundation into frames of drawn comb.

Failure to accept the plastic foundation, under normal and usual circumstances, diminishes the amount of drawn comb, which in turn, reduces brood production, and as a consequence, cuts honey production and

the hive fails to thrive. Then I get frustrated. Or when placed in a hive under less than ideal circumstances, the bees fill up the existing drawn comb, the queen is restricted in her laying ability, and you've got a recipe for swarming.

One of the key factors to drawing out plastic foundation is to place it in a strong, growing, expanding hive with a formidable workforce of young bees. When you start bees on nothing but plastic foundation, the bees are hesitant. Each day they delay means a few more adult bees have died. After a week, a lot of adult bees have died and the hive lacks an up-and-coming generation of young bees. The hive begins the downward spiral.

That's when the beekeeper says, "Yeah, I tried plastic foundation. Nothing but a pain in my backside. The bees hated it and so do I."

To paraphrase an old axiom, "if the bees ain't happy, then the beekeeper ain't happy." (This is especially true if "momma" is the beekeeper.) Plastic frames, for all they promise, have generated no modicum of frustration and resistance from both bee and beekeeper. Most beekeepers simply grumble and mumble, "Not worth it."

There appears to be more than ample interest in plastic frames, and yet I continue to hear a lack of accompanying success. The future of beekeeping with plastic is dismissed as nothing but a passing fad. Looks like I'm going to spend another winter assembling wood/wax frames, again. Thank goodness for football. I can only hope the Minnesota Vikings do better than last year.

Perhaps my biggest concern about the challenges of plastic is for the beginning beekeeper who likely lacks the patience, skill and availability of time to assemble wood frames, yet also lacks the essential managerial insights required to entice the bees to accept plastic foundation.

Plastic, and the perceived benefits, is too great a temptation to pass up for that hopeful person who wants to get a start in beekeeping.

And do you notice how most "complete beginner's kits" in the supply catalogs laud plastic foundation? Success with plastic is elusive, and would be especially so for first-year beekeepers who purchase packages and attempt to establish the package on plastic foundation. I really like to see first-year beekeepers experience success. I always encourage first-year rookies to start with wax foundation. Unless you have everything in your

favor, plastic is an uphill battle for both the bees and the first-year beekeeper. I can almost guarantee a mediocre season of disappointment if they attempt to establish packages on plastic foundation.

Over the years, as I've purchased odd lots of bee equipment from retired beekeepers, I've come across good wood frames with serious wax moth damage. It was my preference to purchase the plain sheets of plastic foundation to replace the damaged wax comb. Basically I create a "hybrid" of wood frame and plastic foundation. In my mind, inserting plastic was much simpler than rewiring the horizontal wires and purchasing new wax foundation.

Here are two of my quirky faults. **First**, if I'm going to install wax foundation, I have a great preference for adding horizontal wires, even with crimp-wired reinforced foundation. The horizontal wires I add might not be necessary, especially in the brood chamber, but my experience with a tangential, two-frame extractor warns me otherwise.

I want good support if I'm using wax foundation, but horizontal wires require additional time, especially if you've got to clean out a well-propolized used frame. Time continues to be my resource in shortest supply, but there's nothing more frustrating than having wax foundation warp, bow, sag or blow out. Then all my time and energy goes for naught. And wax foundation is expensive and once it is ruined, you've got to replace it.

Second, plastic inserts really do best if you have frames with a grooved bottom bar (GBB). With divided bottom bars, the plastic insert has a tendency to ignore all my attempts to secure it to the top bar and it will slide down between slot in the bottom of the frame. Which also leads me to conclude it may be best, that is, *more efficient*, to utilize all new equipment, especially frames with a groove bottom bar, as opposed to cleaning and refitting worn old equipment. But that's a topic for another day as well.

There have been times I've almost given up on plastic and returned to wax foundation. But the labor and time involved continues to bring me back to the convenience of plastic. But the bees' reluctance left me frustrated. It wasn't until I resolved myself to work the plastic until the bees accepted it that I found success with plastic foundation.

Yes, Virginia, you can get your bees to work plastic foundation into lovely drawn comb.

I believe the plastic, in and of itself, is not the problem. There are some beekeepers who succeed marvelously and get the bees to work plastic foundation without complaint. In some instances, I've had good acceptance in some of my hives. But my previous success has not been consistent.

I believe the problem with acceptance is also related to resistance and ignorance on the part of the beekeeper. It takes special management skills to tweak the bees, just like when you hide steamed peas in the mashed potatoes hoping your five-year old won't notice. That was the trick my mother finally used on my younger brother.

Let's Get 'R Done: Overcoming the Resistance to Plastic Foundation

(Your's and the bee's)

From the very beginning of my beekeeping journey in 1981, I've been infatuated with plastic foundation. I love the perceived idealism of opening a shipping carton of these one-piece units and moving them directly into the hive body. My bees have been a different story.

I started my beekeeping career with a couple of cases of Pierco-brand frames and a pick-up bed full of nucs. With the explosive and seasonally-intense flow of a Minnesota summer, I had no problems with the acceptance of plastic frames. The bees did a masterful job of drawing out the foundation to produce a beautiful crop of honey.

While I didn't know it at the time, I possessed the major keys for success with plastic foundation: a good, healthy hive of young bees and emerging brood headed by a young, vigorous queen, during an intense nectar flow, and the needs of the colony to make room for an expanding population of bees.

Sometimes a little luck also helps. And there are beekeepers who have this luck. They have all the right circumstances and situations fall their way. These are the beekeepers who say, "Well, I've never had any problem with plastic foundation."

If this is you, count your blessings. For the rest of us, we've got to work a little harder, a little smarter.

I'm now living in southeast Missouri and our nectar flow is much shorter, less intense, even fickle at times. And my success with plastic foundation is likewise shorter, less intense, and at times, fickle. I long for the ease of my former success, but I also have to realize we have a host of other complications since my pre-mite beekeeping days in Minnesota.

And I'm not crazy about those Minnesota winters to move back.

The present dilemma is simple: my bees are not in love with the idea of drawing out plastic foundation. They get balky. I get frustrated. Some people say, "You just got to 'starve' them to it, offer them nothing but plastic. That'll get them to draw it out."

Unfortunately, the bees are not amenable to that kind of logic. They don't draw; they dwindle. Then we both lose. And it's a familiar story in beekeeping circles around the country.

Despite several years of frustrating results and inconsistent outcomes, I continued to prefer plastic foundation, particularly the "Pierco-style," all-in-one frame/foundation. I continued to believe. A lot of my beekeeping buddies told me it was nothing but a fantasy, a myth, more trouble than it was worth. I refused to give up. They thought I was nuts.

I believed in the Camelot-like existence where bees readily accepted plastic foundation and all my replacement frame issues were laid to rest. I knew I just had to persevere. But when you do the same things in the same way you're going to get the same results. That's the definition of insanity.

I had to find some different way, a different approach, a different method. I had to change what could be changed and accept what was not going to change. And I had to pray to know the difference. That's the definition of serenity.

The promise of the time-saving convenience continued to gnaw at my consciousness. I love a good challenge, but with more and more beehives, making plastic foundation work was becoming more than a necessity. It became my mission.

So What Does It Take?

While I like the benefits of plastic foundation, my bees absolutely refuse to read the sales literature and promotional material (maybe they have better things to do!). So I'm presented with the challenging opportunity of convincing, perhaps persuading my bees to see things my way and make better use of plastic foundation.

Here's where a lot of us make our first mistake with plastic foundation. We simply add plastic foundation to our existing hives in the same way we add wax foundation and hope the bees draw it out into comb.

The reality is this: the bees are very reluctant to draw it out. They may draw out a few frames or maybe none. And one hive will do fine and another hive will languish. The inconsistency is maddening.

The reluctance of the bees to draw out the plastic foundation causes them to start storing nectar in the existing drawn comb in the brood chamber. This creates congestion. I define "congestion" as the competition for available cell space between the developing brood and the colony's need to store incoming nectar.

Congestion will trigger swarming. If you allow a hive to swarm, you've lost a majority of the workforce and you've postponed the expansion of the population that would stimulate the bees to draw out more foundation to make more room for the queen to lay additional eggs. With a reduced workforce, there's less nectar brought in and a decreased need to create additional comb for nectar storage.

One of the tricks of enticing bees to draw out foundation is to limit the availability of drawn comb. If you restrict the frames of drawn comb and replace them with new foundation, the bees will feel an urgency to draw the foundation into comb. Basically, the bees sense the need to make room for incoming nectar and the necessity of giving the queen more room to lay eggs. I would add that this works best in a strong, highly-populated colony.

However, there's a catch-22: If you don't keep an eye on things and add too much new foundation, the existing frames of drawn comb could easily become congested with in-coming nectar before the frames of new foundation are drawn out. You might accidentally stimulate the swarming impulse. And I would add this is most likely to occur in a strong, highly-populated colony.

If I was pressed to reveal my most inviolate axiom upon which determines the success or frustration of today's beekeeper, it would be this:

Do Not Let Your Colonies Swarm!

And to paraphrase Winston Churchill, "Never, never, never let your colonies swarm." I am passionately adamant that if more beekeepers made swarm prevention a priority, they'd have more productive colonies and larger honey crops. I firmly believe there is no greater, single factor to my success than to eliminate swarming. And this success is achieved on several levels.

In a nutshell, the successful beekeeper needs to provide the proactive management that will eliminate the conditions that lead to swarming. And yes, this can be done. But it takes work and it's a topic for another day.

Keys to Success

I've borrowed an old barroom lament of, "So what's a guy got to do to get some plastic foundation drawn out around here?"

In response I come up with several techniques and tips, and the more you can incorporate, the better. As things will vary (weather, strength of hive, etc.,) the more you work with your bees, the better your acceptance of plastic foundation.

Though I was benignly ignorant during my rookie year in Minnesota, I stumbled upon the right conditions at the right time. Basically, I was lucky.

You will have fewer problems with plastic foundation if you have a **healthy, strong colony with young bees and emerging brood headed by a vigorous queen** with plastic introduced during a **seasonally-strong nectar flow**.

If you can **limit the availability of drawn comb**, forcing the bees to work on the plastic out of necessity, without inducing the swarming impulse, you will reduce the resistance and have a fairly easy time with plastic foundation. I don't always have all these factors in southeast Missouri.

It also helps if you have a **vigorous race of bees** that rapidly builds comb and readily draws out foundation. I had Italian queens in my first-

year nucs. Today, I tend to favor locally-adapted queens raised from feral swarms and survivor colonies and they don't always think plastic foundation is the best choice.

I continue to raise my own queens from the bees that survive without chemicals as my principle means of genetic selection. Additionally, I'm choosing to raise queens from the hives that accept plastic foundation more readily than other colonies. But there are also days that I wonder if I shouldn't buy some queens that produce progeny that love to draw out comb.

So right away, here are eleven key factors in drawing out plastic foundation. How many of these are within your managerial control?:

1. A strong hive
2. Healthy bees
3. Emerging brood
4. Vigorous queen
5. Expanding brood nest
6. Lots of incoming nectar with a seasonally strong, intense flow
7. Limited availability of drawn comb
8. Presentation of new foundation
9. A vigorous race of bees
10. Good weather for foraging
11. A little luck

Further, I've found if I take out the outer frame from the edge of the hive body, what we often refer to as the #1 or the #10 position, then create an opening in the middle of the brood nest and **slide a new frame of plastic foundation between two frames of open brood**, the bees jump all over the frame and it is readily drawn out. I believe the higher concentration of younger "nurse" bees who still possess active wax glands, and the necessity to continue to create comb for an expanding brood population are the significant factors here.

It's not enough to simply add new foundation to your colony. To borrow the three secrets to selling real estate, it's location, location, location. And so it is with introducing plastic foundation to a nice, strong hive.

By placing new foundation where it is accessible and "in the way," that is, in the middle of the brood box, you'll hasten the acceptance. I add new

plastic foundation in the middle of expanding brood boxes in late April and early May (not the first nor last period of spring expansion but in the middle of it) which also is done in conjunction with swarm prevention and control.

And don't forget what I said about preventing swarms.

If I was pressed to limit my options to one technique to accelerate the acceptance of plastic foundation, it would be placing new foundation between two frames of brood. If I was short on time and energy, this is the number one managerial investment that pays the greatest dividends when it comes to drawing out plastic foundation.

Removing one of the outer frames of drawn comb is fairly easy as these frames usually contain only honey and pollen, and in the early spring, many of these frames are just plain empty. I generally place these frames in storage and save them for my queen-rearing colonies.

This technique of sliding new foundation between two frames of brood works best in the strong colony—and you'll probably start to catch my drift that strong colonies are one of the key factors to a host of current challenges of modern beekeeping. And along these lines, it has been my experience that starting packages and swarms on plastic foundation is disastrous.

In side-by-side comparisons of purchased packages for my bee yard, packages established on ten frames of wax foundation were much more successful than packages established on ten frames of plastic foundation. The difference is significant. Even when a couple of frames of fully-drawn comb were added at the time of installation of the package started on plastic foundation, the package bees quickly jumped to the drawn comb, but soon languished refusing to move over to the plastic. All packages were fed sugar syrup.

Likewise, feral swarms shaken into hive bodies with ten frames of wax foundation flourished while swarms shaken into hive bodies with ten frames of plastic foundation seemed to stumble along with limited production. Feral swarms seemed to be less reluctant than packages when forced to establish their colony on nothing but plastic foundation, yet there is a great hesitancy, even when fed syrup, even during a major nectar flow for feral swarms to accept plastic foundation.

Unless a colony is well established with young bees and emerging brood, plastic foundation is an uphill battle. Packages on plastic have never done well for me, and once they lose their edge and the adult bees start dying, I just have to throw in the towel. Weak hives just never seem to come back around and surge forward to anything close to being able to sustain themselves. It's a waste of time and energy, mine and the bees.

And again, let me reiterate your experience may be different than mine. Our nectar flow seems to ebb and flow, push hard and retreat. In my attempts to hive feral swarms, timing is everything. It is very true that a swarm in May is worth a load of hay. They'll prosper quite nicely. Swarms caught in July, yeah, I should just let them fly. Even when fed copious volumes of syrup, they just don't seem to have that vigor of an earlier swarm.

Further, feral swarms have queens of different ages, populations of different strengths from different races of bees and then the weather is so different during a "typical" Missouri summer. Even from one year to the next, things are different and I'm sure your results will differ as well.

In other conversations, many people recommend **spraying the frames with sugar syrup**, and in some cases, enhancing the syrup with a stimulative product called Honey-B-Healthy®.

My initial experience with this technique was remarkably unsuccessful. The syrup quickly beaded up and ran off the frame when it became vertical. I was corrected, in that I was told not to "spray" the syrup, but rather to "mist" the frame with just enough syrup that it won't bead up and run off.

With all due respect, this never worked for me. The bees lapped up the misted syrup and ignored the plastic foundation. I find it hard to believe that this miniscule amount of sugar syrup can fool a bee into thinking plastic foundation is worth working on.

Another suggestion I tested is to **increase the amount of wax coating** that is nominally applied by the manufacturer. Almost every brand of plastic foundation sold today comes with a negligible coating of beeswax. Several experts recommend adding an additional coat of wax to make the plastic more palatable.

At first, I balked at this idea. It's more work. It takes more time. And why should I have to redo what the manufacturer already did? But then

I had to affirm my mission is to get plastic foundation drawn out. My purpose is to figure out how to increase the acceptance of plastic to the same plane as wax foundation so I can enjoy the benefits of plastic.

I had to question my personal integrity: Was I willing to do whatever it takes to get those ornery bees to draw out that plastic? I guess I was because I went to work giving my plastic foundation another coat of bees wax.

In my own experiments I had a wonderful acceptance with plastic foundation after I coated it with additional wax. In two experiments in my bee yard, the additional wax brought the acceptance of the plastic foundation up to the same level as wood-bound frames with crimp-wired, wax foundation. I've detailed the process of how I added this layer of additional wax to the foundation later in this manuscript.

In another experiment, I placed ten frames of plastic foundation in a super, with extra wax coating added to three frames in the #3, #5, and #8 positions within the ten-frame super. This occurred in May during our normal nectar flow. Checking on the development on a weekly basis, the bees quickly, and without any hesitation, began drawing out the three frames that had the additional coating of wax first, then spread to the adjacent frames with the normal, nominal wax coating applied by the manufacturer.

Repeating the experiment using two frames coated with additional wax in the #2 and the #9 position, the same result occurred. The bees were drawn to these two frames with additional wax, and once they started on these frames, the bees started drawing out adjacent plastic frames.

In my opinion, these experiments showed the time and labor for adding the additional wax coating is an astute management practice that "levels the playing field." You obtain all the benefits and advantages of plastic foundation and you've made plastic as attractive as wax foundation to the bees.

These experiments also showed that it may not be necessary to apply additional wax to all the frames in a super. Perhaps coating every-other frame would suffice, and this will save some time on our part. Applying additional wax creates a magnet-like effect and draws the bees to that respective frame. Once drawn to that frame they quickly spread out to the other, uncoated frames.

Next year I'm going to expand this technique and experiment with "frosting" the frames. I can buy a bucket of baker's frosting from the local bakery, or I can make my own frosting from powdered sugar and small amounts of hot water. It's like making a grease patty, only go easy on the water. I wonder if I can get the bees to accept the plastic foundation if I coat them with frosting, basically a sugar coating.

Other Tips and Tricks

There are some additional and easy tips to facilitate the acceptance of plastic foundation.

Always start ten frames in your boxes. My experience starting nine frames of plastic foundation only proved that the bees will draw out a parallel plane of comb, about ¼" to the side of the plastic foundation. Given a large enough space, the bees greatly prefer to draw out their own cell-size agenda to that of the plastic foundation. Once the frame is drawn comb, you can reduce the number of frames to nine in each super.

Don't mix wax and plastic foundation in the same super. If you mix your foundation, especially if you alternate wax and plastic, you'll get big, fat, overdrawn frames of the preferred wax foundation and a skinny, if not totally ignored, despised plastic foundation. However, once frames are drawn out, it makes little difference either way and you can mix frames that started out as wax and plastic without negative consequences.

Crowd your bees. If you add a super of plastic foundation, crowd your bees. In the production of comb honey this process is called, "the cut down phase." Basically, the colony is squeezed into one brood box and the population of bees bubbles up into a new super. The power to draw out this new super is incredible, and given the need to draw out new foundation, along with a shortage of available drawn comb, the bees really go to work.

This is similar to my earlier recommendation to limiting the availability of drawn comb by removing frames of comb and inserting frames of foundation. Crowding will force them to move up into the super and don't offer them the more attractive alternative of a super of empty frames of drawn comb.

The bees will normally utilize the empty cells of drawn comb first, and only when once filled with nectar will they move to the new plastic. If you crowd your bees, that is, limit the available drawn comb and at the same time offer new foundation, they will take to the foundation faster than if more drawn comb was available.

But watch out for swarming, and remember the impulse to swarm is triggered several weeks prior to finding sealed swarm cells. If you remove too much drawn comb and offer too much new foundation, it's possible to create a congested brood nest and trigger the swarming impulse.

Don't expand too fast. My best techniques for introducing plastic foundation has been to add only one super at a time, and only when seven of those ten frames have wax on them will I add another super. Generally, before adding that next super, I'll pull the outer, mostly ignored frames and move them to the middle of the super. Then I'm ready to add my next super.

Bottom super. Most of us prefer to top super, that is, adding a super on top of the existing supers. It's easier and it takes less labor. However, bottom supering, adding the new super underneath and below the existing supers, greatly enhances the bees' acceptance of plastic foundation.

Create a top entrance. I don't know why this works, but I observed colonies with top entrances, even a notch in the lower edge of the inner cover, seemed to draw out the plastic foundation quicker and with less hesitation.

It may purely be an anecdotal observation ignorant of a hundred other variables, but supers with a $\frac{3}{4}$ " hole drilled in the lower portion of the front of the super (under the hand hold) seemed to have more plastic foundation drawn into comb than conventional supers with similar plastic foundation.

And I make this recommendation with all due respect to those beekeepers who would rather take a poke in the eye with dull hive tool before they drilled any holes in their supers.

Don't use a queen excluder under a super of plastic foundation. A queen excluder between the brood nest and a super of new, plastic foundation is a recipe for congestion. Unless there is drawn comb above the excluder, dynamite and wild horses will not drive those worker bees to move

up into the super through a queen excluder. Perhaps this is where the queen excluder has been erroneously demoted as the “honey excluder.”

It is better to allow the bees to move up and draw out the foundation into comb, even at the risk of the queen laying eggs. Then later you’ll need to move the queen to the lower boxes and add the excluder with enough time to allow the brood in the super to mature and emerge prior to your extraction date.

Don’t push the bees after the nectar flow is over, and even if you feed them, don’t expect them to be fooled into drawing out multiple supers of plastic foundation. Our nectar flow in this part of southeast Missouri dries up in mid-July. From mid-July until Labor Day, there is virtually no nectar. We’re also very short on rain. And the bees seem to sense the futility of the seasonal lull. They just don’t seem to have the energy to draw out plastic foundation.

After my honey harvest following the 4th of July, I’ve tried to fool the bees into a continued expansion by feeding syrups of varied concentrations. The bees prefer to store the syrup in existing comb and the queen just seems to kick back and take a little vacation. But this may also result from the fact that many of my queens originate from locally-adapted, feral swarms. Perhaps I need to introduce a race that is a vigorous brooder and an aggressive comb builder, e.g. Italians.

Orient your frames to a North-South direction. Yep, I bet this one just about caused you to drop your dentures. I did some cut-outs in a shaded location, and interestingly, the combs were oriented in a North-South direction. I even moved two colonies that had taken up residence in a storage shed, on two different walls, and the combs were laid out in a North to South orientation. Perhaps it’s just an isolated anecdote.

But then I began to notice how colonies with frames laid out in a North to South orientation would draw out plastic foundation more successfully than the colonies that were sitting with their frames lined up in an East to West orientation. And those supers where the frames were lined up East to West also had more “brace comb” manufactured by the bees that ran perpendicular to the face of the plastic foundation, and yes, that brace comb ran North to South.

Hmmmmmm. Again, this was probably an isolated incident of an anecdotal observation. But I’ll be lining up my colonies with the entrance

facing South, as opposed to my normal method of lining up the entrance facing East (a move thought to “wake up” the bees earlier with an entrance that faced the rising morning sun).

Some Concluding Thoughts

Plastic frames/foundation are not perfect. And yet I cannot argue the ease and economical practicality are sufficient reasons to overcome the challenges. I’m also quick to remind beekeepers that plastic foundation requires a better, more astute management than wax, but the benefits make plastic frames a prudent choice.

In my own experience, I have a warm affinity for plastic foundation. If I could get the bees to agree with me, I wouldn’t start any wax foundation at all. Though an old-time beekeeper might complain everything about plastic foundation is the antithesis of the natural qualities of nature’s perfect food, plastic may become the standard once beekeepers hone their management skills to overcome the bees’ reluctance.

I firmly believe the benefits and advantages outweigh the challenges. Plastic may soon become the choice of a new generation once the bees train us to make it more presentable.

Okay, I Got It Drawn. Now What?

The late George Imirie (1923 – 2007) was passionate about preserving drawn comb. He said it was the beekeeper’s greatest asset and any beekeeper worth their salt would strive to protect it.

If you’ve successfully persuaded your bees to draw plastic foundation into lovely honeycomb, don’t fall asleep at the switch and allow moths or mice to destroy all that good work. Stay awake! Keep a vigilant and watchful effort to protect that comb. Don’t let all your efforts fade away.

It’s hard enough to tweak your bees into accepting plastic foundation. Don’t put yourself back at the starting gate next spring due to your procrastination or neglect. Protect that drawn comb.

Is There a Downside to Plastic Foundation?

When asked if there is a downside to plastic foundation, other than the bees' hesitancy to lovingly embrace it, the first thing that comes to mind is the cost. There is a perception that plastic foundation costs more, and the number one objection to plastic foundation is that it is just too expensive.

Really? Have you really looked at the costs?

Later in this manuscript I'll take a look at the figures, actual figures from the supply catalogs and it will surprise you. The cost differences between wood/wax and wood/plastic and one-piece plastic are not that great.

A second objection that comes is that plastic is not "natural." Frames made of wood and wax are "natural," that is, made from nature. It's hard to argue this point, but the real question is this: because plastic is "unnatural," does plastic foundation have a negative effect on the bees? Are fumes given off? Does plastic emit some toxic substance as it ages or slowly degrades?

We don't know. Our ignorance may be the biggest downside because we don't know if anything harmful or toxic is released from what is basically a petroleum product.

However, one of the things we are finding is that wax foundation purchased from the supply catalogs is testing positive for chemical residues left behind by miticides and pesticides. That may be something to think about.

A third objection comes from those who study the "waggle" dance, the bees' method of communication. Does plastic foundation restrict the communication process which is based, in part, on the reception of vibrations?

We don't know. Nothing has been tested to lead us to any firm conclusion other than the speculation brought on by our fear-induced imaginations.

A fourth objection focuses on the thermal regulation of the frames, specifically brood frames. Does plastic interfere with the colony's ability to stay warm in the winter or cool in the summer?

We don't know.

There has been much speculation but nothing has proven either true or false. The problem is with beekeepers who have problems with the acceptance of plastic foundation typically jump to find a cause why their hives failed to flourish. They will say the only thing they did differently was to introduce plastic foundation into a colony and the colony swarmed, died, starved, froze out...whatever. Since the only thing they did differently was to introduce plastic foundation, plastic becomes the scapegoat.

When asked to explain further or provide more details, some of the beekeepers I've talked to just mutter and say, "I just don't like it. I don't care for plastic foundation."

And this is too bad, in part because they're missing the advantages of plastic foundation (which could be easily corrected), and in part because they incorrectly blame plastic foundation which only fuels the unjustified negativity.

Applying Additional Coats of Extra Wax

It's easy to add an additional layer of beeswax to your plastic foundation. For my application I melted my own beeswax from cappings in a crock pot. I bought a used crock pot at a garage sale just for this purpose. You might do better with a double boiler as it takes about 3 hours to get the beeswax hot enough in a crock pot, and you definitely want the wax hot.

But here's a "marriage saving" tip. No matter what you're doing in the beeyard or in the extracting room or in your workshop, never, never, never use any good appliance from the kitchen for a chore or project that will leave the appliance hopeless gooped up with wax or propolis. If you can't find one at a garage sale for a couple of bucks, it would be far better for you to buy your spouse the brand-new crock pot of her (or his) dreams and use the old one for your wax-melting project.

I speak from experience thinking I could just "borrow" the appliance and clean it up later. Here's another tip: you'll never clean it up good enough for your spouse to want to reuse it in the kitchen.

You have been warned!

So I found a used crock pot at a garage sale for a cheap price. Next, I went to my giant big-box, discount retailer that specializes in products made in China. I purchased a Rubbermaid® 4"/100mm foam roller for about three dollars (and yes, it was made in China).

I laid a medium frame on the top of my work bench. I dipped the foam roller into the hot beeswax for about three seconds, then rolled the wax across the face of this medium frame using average pressure. I rolled first from side to side, the long way, then rolled up and down, the short way.

I dipped the roller a second time as one dip is not quite enough to really finish and completely coat the face of the medium frame. Work quickly as the wax cools fairly rapidly. The second rolling will not use up all the wax in the roller, but by the time you flip the frame over, the roller has cooled sufficiently to warrant a fresh dipping.

Flip the frame over and dip, roll, dip and roll until you finish covering the surface of the frame. When you roll, act like you're painting the surface, because you basically are. With brood frames, you will need to dip three times. Work rapidly as the slower your pace, the more the wax cools and will not roll out as well. Don't worry if your coating is uneven. Just cover the whole surface.

For my research, I weighed each frame on a digital postal scale, using grams as opposed to ounces to simplify the math. I weighed the frame, applied the wax, then weighed the frame again making note of the two weights. Later I set down with a calculator to subtract the two weights to find out how much wax I was adding, then averaged the amount of wax added.

The range of the wax added to medium frames ran from lows of 40 grams upwards to highs of 60 grams. A lot depends on how much pressure you use to squeeze out more or less wax from the roller. It's not an exact science and the variables of wax temperature, frame temperature, roller pressure and overlaps will dictate how much wax is applied. I felt I was generous with my application. The difference in the weights of wax application was insignificant to the bees' acceptance.

In my applications, the average wax added to the medium frames was 48 grams, which works out to be about 1.7 ounces per frame. Brood frames took about 72 grams on average, and that works out to be about 2.5 ounces

per frame. To figure out how much total wax you need, you can take my figures and multiply them by the number of frames you want to coat. That will give you a start.

If you want to push the economics further, I sold some beeswax to a candle maker for \$3.00 a pound. At that price, I've increased the cost of my medium frames by 32 cents (for 1.7 ounces) and my brood frames by 47 cents (for 2.5 ounces), not including my time and labor. But at this investment, with the increased acceptance, I feel it is well worth the extra wax. And it makes good use of my beeswax.

I can only guess that the addition of wax on the foundation assisted the bees in working the plastic foundation into comb, that hopefully, that wax was reworked into honeycomb making the bees' work more efficient.

So What Does It Really Cost?: The Economics of Plastic Foundation

How do the costs of plastic foundation really add up? I went to several leading beekeeping suppliers, via their catalogs and web sites, to price the components of frames. In an attempt to compare like quantities and qualities, recognizing that unit prices decline with larger orders and shipping will need to be added, I set out to find the average costs of plastic foundation. Shop around as some suppliers charge more, some less. What I present is an average, and rest assured, prices will be higher next year.

For the conventional wood frame with crimp-wired, wax foundation, with supporting horizontal wires, the average costs for wood frames is 82 cents and the average cost of crimp-wired, wax foundation is 89 cents for an average total of \$1.71 per frame.

Then you also have your labor. If I place an estimated opportunity cost of \$10 per hour (or if I could talk my kids into working for this rate), and as I've roughly timed myself at assembling, wiring and installing wax foundation at 32 frames per hour. My labor costs add another 31 cents per frame. I come up with a total cost of \$2.02 per frame.

For the wood-bound, plastic foundation frame, the "hybrid," I have an average cost of the wood frame at 82 cents, with the average cost of plastic inserts at 98 cents for a total cost of \$1.80 per frame.

I can sit down and assemble and insert about 45 frames in an hour's time. If I want to coat these frames with melted wax, I'm going to add another 47 cents for wax, and using my costs of \$10 per hour to add 22 cents per frame for assembly labor, and 13 cents for waxing labor, I come up with a cost of \$2.62 per frame.

The all-in-one piece plastic frame/foundation averages a cost of \$1.83 right out of the box. If I add my opportunity costs of the additional wax, and that once I get set up, I can easily coat 80 frames in an hour (that's about one per minute). So I add an additional 47 cents for wax and 13 cents for waxing labor for a total of \$2.43 per frame.

Interestingly, a couple of companies sell pre-assembled "hybrid," wood-frame and plastic foundation frames averaging \$2.40 per frame. Adding my wax and the associated labor costs would push these expenses up to \$3.00 per frame for pre-assembled, wood frame, plastic foundation "hybrid" frames with my addition of another wax coat.

Here's how it shapes up. The first column shows how the three frame formats stack up from pure, out-of-pocket costs. The second column provides the additional opportunity costs for wax and labor, if that is something important to you. If you don't want to "reimburse" yourself for your labor, then use the first column which represents the true, actual "out of pocket" costs.

Plain wood-frame, wax foundation	\$1.71	\$2.02
Hybrid wood frame, plastic foundation	\$1.80	\$2.62
All-in-one piece plastic frame/foundation	\$1.83	\$2.43
Pre-assembled wood-frame, plastic foundation	\$2.40	\$3.00

These are average prices for small quantities of brood frames. They will give a relative comparison of the costs but you can fine-tune and make adjustments for medium and shallow frames. If you have wax cappings sitting around with no other available market, and if you don't necessarily want to charge yourself for your own labor, then you can take those costs out of the picture.

Additionally, I find beekeepers have a specific loyalty to certain suppliers despite the costs or location. You'll have to sit down and work out your own financial analysis. Further, if you don't reinforce the wax, brood

foundation with horizontal wires, you can assemble more wood frames. Use my figures for relative comparisons.

Last Thoughts

It's no secret that wax foundation is uniquely and unconditionally accepted by the bees and that plastic foundation is frequently ignored, despised and rejected leading to an unproductive, if not dwindling colony and a frustrated beekeeper.

Plastic foundation is not perfect and requires additional management skills. But I also believe it's not an impossibility for the average beekeeper.

Sometimes it just takes a little more effort, in the right way and at the right time, to enjoy all the benefits and advantages of plastic foundation while enjoying an acceptance on the same level as wax foundation. It's my opinion that the extra work it takes to make plastic acceptable to the bees is more than justified as I enjoy the benefits of plastic foundation.

I wish you well.