



SmartPref PBS - A Crew Responsive PBS

The following dialogue clarifies the many problems inherent with conventional PBS and illustrates how SmartPref overcomes these shortcomings. This offers you the knowledge and facts needed to make the best choice when selecting a PBS for your crewmembers.

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Crewing Solutions LLC
11130 Sunrise Valley Drive
Suite 210
Reston, VA 20191

703 938 0088
www.crewingsolutions.com

SmartPref PBS Introduction

Hello,

I'm Steve Jaros, and I am a recently retired 757/767 captain from Continental Airlines. Besides flying the line throughout my 26 year career, I worked for my fellow pilots in the capacity as Vice Chairman of several union scheduling committees, most recently the CAL ALPA's Pairing and Line Committee. Also in the past couple years I worked with the Carmen PBS system as it was being implemented at CAL as we transitioned from hard lines to PBS.

Either hard lines or PBS, the complaints/comments I heard were generally the same.

These comments were in the form of "how come these lines were built this way" (i.e., not enough days off, not built for commuters, built too much for commuters, fill trips added, no variety, not enough turn lines, and on and on).

With the advent of conventional PBS such as the Carmen PBS system, the recurring pilot complaint was also similar, "how come my line was built this way? I never expected that!" And when I say "never expected," I mean unforeseen schedules with significant impact on pay or personal life-or both.

In conventional PBS the uncertainties of bidding in the blind usually far outweigh the theoretical advantages of PBS, especially for the bottom 70% of bidders. Folks, bidding in a conventional PBS environment is difficult to say the least. These questions that crews constantly ask should not have to be asked.

I ask you now to consider a crew-responsive PBS system called SmartPref.

Navigating your way through any PBS environment involves many decisions. But bidding under conventional PBS, is like trying to drive your bid around a blind curve - you can only hope you stay on the road. If you do hit the guardrail, you tell yourself that you "learned your lesson and can suffer thru a week or to for that month." If you fly over the guardrail and down the embankment, the entire month can be shattered for you and your family.

The real issue is that every bidder always has adjustments to their lives that influence how they bid each month. The curve next month won't be like the last. These variations greatly affect what one can hold and are not clear within a conventional PBS. In fact the very details that you need to bid correctly are only available after the bidding period has closed. Ironically, you can, to some extent, find out why you got the line you did, but only after the chance to fix it has passed. In all my time bidding under conventional PBS, even if I could understand the reasons report, I never felt any better about the undesired schedule I was more or less committed to for the next month. At least under the old hard line concept I could see or depend on the worst case line I could hold. Yes, I just might be awarded that bottom line with 12 days off and work all weekends. Yet, I could at least see it, understand it, and make personal arrangements for that month, giving me more knowledge of what to expect.

In conventional PBS a lot of the information important to the crewmember --such as when a global constraint is in effect, the days on which I will be forced to work due to stack, which trips

and days off remain available at my seniority level - only becomes apparent after the bids are awarded. But bidding successfully requires the ability to test your requests against these constraints.

You need to be able to try different bids and see results so you can fine-tune or totally change your bid. Additionally if junior, you need to be able to see the effects of requesting either a hard line or a reserve line based on days off. You need at a minimum that information.

And there are many important "what ifs" that conventional PBS can't answer in a timely manner: If it's a high line average month, what will be the impact on my line? If I waive credit of any kind, what will be the impact on my pay? If I slide my vacation, what impact will it have on my schedule? If I have training (or any other absence), what impact will it have on my line?

SmartPref addresses all these issues and more.

Today, with SmartPref you can have the system that let's you see your improvements as you make your adjustments. SmartPref was designed from the ground up, with the crewmember in mind. SmartPref meets the basic scheduling foundation that crews have the right to generate gratifying monthly lines.

SmartPref is NOT conventional PBS; rather it is the only PBS which is crew-responsive. You can only get this crew-responsive PBS from Crewing Solutions.

So please explore our website, exercise our demo, and call us. I look forward to speaking with you.

Thank you.

Chapter 1 Introduction

Hello, I am Gyro, a recently retired Captain for Continental Airlines and a pilot who has bid conventional PBS systems using the original SBS SLIC and more recently the Carmen PBS. As a former Vice Chairman of CAL's independent union and later CALALPA Scheduling Committees, I know PBS can be a better way than bidding hard lines, but only if you, the bidder are given the controls of the "bidding aircraft."

When I use the term "conventional PBS", I am referring to Carmen, AOS, Navtech, Kronos, etc. Each of these systems collects bids during the bidding window and processes these bids once the bidding window has closed. This is referred to as Batch Processing. As pilots and flight attendants, we invariably have to fly the result of this batch process.

First and foremost, these conventional PBS systems have many weaknesses, constraints, and limitations as a result of this batch processing which you, as crews, have to deal with. We'll talk about these in the following chapters. Also when transitioning from hard lines to conventional PBS you will be thrown many "confusion factors," caused by not only having to learn how to build your own line but having to do so blindly. Unless you are number one in your BES (base, equipment, status), when bidding, you will most assuredly have the feeling of not being confident that what you are doing is correct.

Airline management gains the financial benefits of any PBS and hopefully your pilot group will share equally in those dollar savings. However, in most cases the crews, when consulted on the design, usability and performance of conventional PBS systems are led down the path of "don't worry; the system will take care of you".

Strongly influenced by crewmember input, SmartPref overcomes the inherent operational flaws of all conventional PBS systems and eliminates the weaknesses, constraints and limitations therein.

What follows are the inherent benefits of SmartPref as compared to conventional PBS. Please listen to each chapter in order or feel free to jump around to those topics that most interest you.

Chapter 2 Monthly Line Builder - My New Job

Unlike the hard lines which were built for you by the company or your committee, PBS requires you to be your own personal line builder. This is either a risky proposition or a grand opportunity for you to build highly rewarding personal schedules. Believe it or not there is a great deal for you to know and consider when becoming your own line builder.

We'll teach you how to make your new job rewarding using SmartPref tools that just aren't available to you in a conventional PBS environment and we'll explain the differences along the way.

First let's talk about what you have to consider before you ever put a bid into the computer. Topping my list are personal items such as vacations, training, carry-in, military leave, etc. that I might have in the month, as well as important personal days such as birthdays, anniversaries, family commitments, etc. These are the same matters you considered when prioritizing lines in the bid packages of old.

Now however you must consider new information. This is what the line builders of old had to consider when building lines.

1. Such things as the FARs, contract rules, and company buffers which are in effect for the month must be applied.
2. You must also know the min/max credit window and the required line average for the month.
3. Also company buffers such as the 30-in-7 which might be 29-in-7 or if your last leg is an international leg of a trip sequence which takes me to 32-in-7 which might actually be 31-in-7 under company rules. To satisfy the FAR requirement for 1-in-7, is it 24 hours free from duty or is it a calendar day off? These are some of the issues you must consider to bid safely and properly and thus legally.

With SmartPref, this necessary information is available to you, but more importantly, you get instant feedback if you fail to apply these issues correctly when bidding. Not so with conventional PBS systems.

What is your relative seniority this month? If you are senior you don't want to bid as if you were in the middle and if you are junior, you probably shouldn't expect to build and receive a "senior" line.

With SmartPref you can always try to be as senior as those above you will allow. Because your bid results are based on senior bidders first, you can and will be able to bid right up to your seniority - something that rarely occurs with conventional PBS.

With regard to bidding, you must be sure to bid for enough time based on the line average required, which usually determines the min/max credit windows. For instance, if you ask for three day trips departing every Monday with layovers in DFW and LAX, make sure these trips will build a line that falls within the min/max credit window. If you do not check this, do not be surprised to find a filler trip or different trips other than your requested three day trips on your awarded line. Or in many cases be surprised to have that bid fail and depending on your vendor, your next or less optimum bid will be built.

With SmartPref, you receive immediate feedback on your pairing choices. Not so with conventional PBS systems. In the example above, at least you can decide for yourself if you want a fill trip and maintain the DFW and LAX three day trips or you can change to a different trip or two and possibly save a day off.

And probably most importantly, you must bid enough trips so that if your first choices are taken, you have given the line builder enough other options/trips so it is able to generate a satisfactory line for you.

With SmartPref, clicking on the BACKUP line tells you immediately if you have bid enough trips - not so with conventional PBS which never lets you know otherwise. When you see all green trips, you know these are trips that you have bid for. If you see black trips, you know that these are trips you did not bid for, we call these trips neutral. If you see a red trip, you know immediately this is a trip that you wanted to avoid. A good strategy then would be to go back and add more trips to your bid, trips you desire and not necessarily what the program desires.

Chapter 3 Monthly Line Builder - Global Constraints

Global constraints are like the weather - you have no control over it, but it affects your flight every time. With your “Nav. chart” to guide you in bidding from Chapter 2, some irregular and intertwined factors which we must also consider include:

How the block time and pairings are distributed through the bid period. A lopsided distribution will affect when you have to work and when you can expect to be off (i.e. December additional flying).

- SmartPref shows you this distribution.

What is the balance between available days off and desired days off? If there are more crewmembers requesting a specific day off than are available that day, then a crewmember on the bubble who might normally hope to hold that day off may not be able to.

- SmartPref lets you know, in real time, the trips and days off available to you. Not so with conventional PBS.

How many hard lines will be created; how many reserve lines, and what is the requirement for open time - zero, 300 hours, 500 hours?

- SmartPref shows you these important numbers. Not so with conventional PBS.

The “Stack” is the system requirement which dictates when you have to work a specific day in order for the system to generate the correct number of total lines or ensure that open time requirements are met. The “Stack” never affects the senior bidder; will touch some mid-level to senior bidders at commonly sought after special holiday periods or such, and will definitely upset the bottom half of the seniority list.

There are three different stacks in play in any PBS - the vertical, the horizontal and time. The effect of the “stack” in conventional PBS is analogous to not having the winds aloft known or programmed in the FMS and never realizing how far these winds have blown you off course until you find you are not even close to your destination. This is the primary reason why, in conventional PBS systems, a trip that the pilot did not bid mysteriously appears on his line or a desired day off was denied.

- With SmartPref, all stacks are shown and become more obvious as senior bidders lock in their bids. Not so with conventional PBS. You can then adjust your bidding accordingly, (i.e. make changes based on what is happening now, in this live environment). True the “stack” may still force you to work when you do not want to, but at the very least you are pre-warned, you (not the computer) can take some positive action to still get to your “destination,” and you are not shocked when your line is awarded.

Taking these global constraints into consideration as well as your personal constraints, you must, every bid period, gather an awareness of what your seniority can hold. In conventional PBS systems, this information is internal and not available to you. This required awareness becomes purely a guess, especially the farther down the seniority list you are. As such, you will have no idea (or continually must estimate) what you can hold, which is why conventional PBS bidding is called “bidding blind.”

- With SmartPref, you have the situational awareness (seniority awareness) to bid successfully and make your new job as line builder easier and far more rewarding. You are not bidding blindly.

Chapter 4 Monthly Line Builder - Bidding and More Bidding

As a pilot or flight attendant, you expect the same line results whether you're bidding via Carmen, Kronos, NavTech, etc. or SmartPref. The difference is that with conventional / limited PBS systems, you enter your bid, hope for a certain result, and wait until the PBS process is over to see the result of your one opportunity to build your line. Often the crewmember finds that he bid an illegal trip combination, did not bid enough trips that he could hold, was awarded trips that he did not want or expect, or certain days off were not awarded because his bid was in conflict internally or with others senior to him.

These are real problems since in the end you have to fly the schedule you've been awarded.

- With SmartPref, you enter that same bid and see the result without delay. You may experiment with multiple bids / strategies for the next ten to fifteen minutes until you are comfortable with what you can hold this month and you bid accordingly. And you may always modify your bid if your personal situation changes or the bid result does not meet your expectation or your requirements.

All PBS systems follow a similar process - your preferences are used to rank all of the trips so as to put them in single file order from the number one desired trip to the least desired trip. After this ranking process is completed, the PBS system uses this ranking to build your line. As you can see, how the trips are ranked has a tremendous impact on the bid result.

The problem is that all conventional PBS systems keep this ranking securely within the system - out of sight from the bidder. This is a significant impediment to bidding successfully, because the way YOU think the trips are ranked and how they are actually ranked by the PBS system is frequently very different. Hence a primary reason why a common PBS complaint is "why did the system give me this trip?" or "I didn't bid for this, I never expected this!"

- The answer to this confusion is clear - make evident the ranking and show the bidder exactly how the system ranks the trips. That is exactly how SmartPref works.

SmartPref displays the ranking of the bidder's preferences in the "Search Results" tab - the pairings are in the exact order of how the system will use them. If the bidder concurs with the ranking, then the trips are added to his bid when he clicks on "Add to Bid" tab. If he does not like the ranking, the bidder rebids until the trips are ranked in his desired order.

Some other primary differences between conventional PBS bidding and SmartPref bidding are that SmartPref alerts you to unforeseen consequences.

In conventional PBS for instance:

- If you bid specific trips how will you know if you can hold them?
- Or if you want two day trips - how many can you hold?
- Did you bid enough trips or enough credit / block time?
- What fillers will you be awarded to make up the time?
- Did you bid below your seniority?

Is a reserve line with your desired days off still available?

All of these problems are easily solved in SmartPref because:

- You can bid your scenarios and immediately know if your scenario is reasonable.
- Available days off and trips at your seniority are shown.
- The backup line will clearly indicate if your bid has enough “depth” meaning if all of the trips shown on your line were no longer available (gone senior), the system has enough additional desired trips to build a satisfactory line for you.

Further, with SmartPref there is no such thing as an infeasible bid. As a pilot you can try to bid for the entire month off or bid for trips that you “know” are senior or illegal in their combination. It does not matter. SmartPref will honor your bid to the extent possible and will always display a legal line that falls within the stipulated minimum and maximum credit values guiding you to where you need changes.

Chapter 5 Monthly Line Builder - Pay or Play, You Chose

This chapter discusses your ability to bid for low time, high time, and for productive trips to maximize monthly pay or days off or both. Questions usually abound such as - If I waive credit of any kind, what will be the impact on my bid/line? In conventional PBS, you can waive credit but you don't have a clue if you waived too much, too little, or should at all.

- In SmartPref, when and how much credit to waive becomes very obvious. In addition, SmartPref automatically considers what trips are available - if senior, bidding more productive trips and maintaining more days off and if junior, still having the ability to have a bigger paycheck, but fewer days off, since the junior trips are usually less productive.

In conventional PBS systems, vacation periods are fixed and shown as a planned absence. Generally, you may slide your vacation a few days early or later before the bid period opens, but you are prevented from knowing what impact this sliding your vacation will have on your final schedule. In many cases and when more junior, a vacation slide of a day or two opens up a whole new set of opportunities. Do you get different days off, possibly more consecutive days off, and/or better trips? None of these “what-if” trials are possible in conventional PBS systems.

- In SmartPref, this advantage becomes readily apparent since SmartPref allows you to slide your vacation (this is usually contractual and limits on number of days slid may be imposed).

Bidding training events at the same time as bidding for trips means more likely line satisfaction. The problem with bidding for training before PBS as is common with conventional PBS systems is that you're building your line in two stages - first training absences and then trips and days off. Taking everything into consideration at the same time obviously can make for a better schedule.

- In SmartPref, all training events are biddable (unless your contract says otherwise). Now when you bid for training, you'll know what training events are left, what pairings remain available to you and what days off remain available to you. With that information, you're more likely to build a more satisfactory line.

What impact will there be on my bid/line in a high line average month? If most senior people bid low (and that seems to be the norm), everyone else could be affected by the “splat” which occurs when the required line average at my seniority level becomes too close to the maximum line credit ceiling. This closeness causes line quality to drop precipitously with associated possible seniority inversions. Conventional PBS gives no clue where that additional time will be placed in your line and honoring of seniority is frequently rejected in order to complete the line solution.

- With SmartPref I can pick virtually where I will work that additional time and can insure my seniority is protected.

With the long run times associated with Carmen and other systems - up to four to seven days to produce results after bids close, trip trading is shut down (blackout periods) in that month during bidding to prevent changes, trades, pickups, etc. that could affect the new bid month.

- With SmartPref, trip trading/pickups can continue normally with no interruption throughout the month, since SmartPref continuously updates itself with crewmember changes from the crew management systems already in place.

Chapter 6 Monthly Line Builder - Reserve Bidding

Reserve rules and reserve lines vary from airline to airline. Even with the most onerous contract reserve rules, SmartPref can ease the pain by allowing reserve holders to bid pre-built blocks of days of reserve in seniority order and thus allow these junior crews to possibly gain some days off they desire.

Secondly, with SmartPref the bidder has the ability to bid a line and, if the results look unsatisfactory, move to a reserve line. This is typically based on the bidder's own decision to improve days off with reserve rather than a flying line. Just having the ability to distinguish at your seniority what reserve line you can hold is worth its weight in gold.

And just like bidding for a line, the bidder can visually see the remaining uncovered reserve blocks and can make more informed decisions in this live and real time environment. If he is on the "bubble" between holding a line or reserve, the bidder not the computer can elect to choose one over the other.

Additionally, the ability for a mixed line is easily achievable with SmartPref (contractual of course), in that junior line holders (again those on the "bubble") may elect to work a week or two of reserve in addition to holding a week or two of trips if that fits their needs. This mixed line option benefits everyone, as more combinations of lines are now available for the junior bidders before having to choose a total reserve line. It also improves the "stack" issues mentioned earlier.

Chapter 7 Line Building Summation

The financial savings and operational efficiencies generated through the PBS process come about as a result of building schedules without conflicts. In that way, you may say that all PBS systems are equivalent. Thus from management's point of view, the goal is usually to move to a PBS environment, any PBS environment, as quickly as possible.

If the financial benefits of PBS are equivalent (and I'll take issue with that in a moment), the question that pilots, flight attendants and management should ask is what system in the market provides crews with the tools to build the best possible personal schedules, since moving to PBS transforms all crews into their own line builders?

The answer is SmartPref is the best personal line builder. With SmartPref, there is clearness of the line building process, immediate information is available, and control over the line building process is in the proper hands, with the crew. Other PBS systems let you enter a bid. Period! End of story! With SmartPref, this is where you start.

Given the same set of parameters, the business benefits generated by SmartPref are higher than with conventional PBS systems because:

1. SmartPref results are generated in minutes and hours - not days.
2. With the continuous updating of the crew files, trip trading can continue without blackout periods.
3. There is increased crew approval of their line awards. Improved quality of work life and personal life that comes about with better schedules, is difficult to put a dollar figure on, but is of significant value to both crews and management.

Finally, SmartPref was developed by Christian Boegner who is credited with developing the first PBS system ever in the mid-seventies. During the 80's and early 90's, the founders of Crewing Solutions, Christian Boegner and Candler Brooks, developed and implemented PBS systems in a number of airlines. Together they have developed and implemented crew pairing, bid line, fair assignment, and PBS and/or crew management systems in approximately 100 airlines worldwide.

These gentlemen have heard what crews want and SmartPref is the result their listening.

Optimized Preferential Bidding Systems

Models and Implementations

by Daniel Tumpson
Crewing Solutions LLC
October 27, 2005

Introduction:

In a conventional PBS, each crewmember sends in his bid (i.e. preferences) without knowing the preferences of other crewmembers. He is bidding "blind". As a consequence, conflicts result: some trips are desired by (i.e. fulfill the preferences of) too many crewmembers and some are desired by no crewmembers. In the post-bid optimization process, the global optimizer attempts to reconcile conflicting bids (as represented by the final set of conflicting preferences). The optimum solution, even if it could be reliably extracted from the huge set of possibilities (using, say, LP and column generation methods), is constrained in quality by the conflicting preferences.

SmartPref, in contrast, transforms the process of bid submission into a "pre-optimization" process, wherein crewmembers are made aware each time they bid of the status of other crewmember bids: e.g. while junior crewmembers are allowed to bid generic preferences that potentially apply to all trips, they are not allowed to bid for specific trips assigned to more senior crewmembers. This feedback from other crewmembers combines with a bidding crewmember's preference information to order the trip choice list and to generate the best quality crew roster available at the time he bids. If his preferences produce a poor roster (e.g. because of conflicts with senior crew), the bidding crewmember may change his preferences until the roster he likes the best and which is also compatible with other crew bids is generated. The resulting bid, then, is "locally optimal" in that both the bid roster and the bid preference parameters are the best they can be given the present state of the solution and the seniority of the crewmember. To insure that this feedback is available from the beginning of the bid period, a reliable initial solution is generated from the standby bids of each crewmember.

By the end of the bid period, the bidding crew members have not only generated what they consider to be the best rosters that are compatible with other crewmembers, but also the preferences that they consider to be the most realistic given feedback from other crewmembers. Since the interactive bid process generates both a solution (set of rosters) and a crew-approved set of preferences, the interactive bid process simultaneously optimizes both crew preferences and crew rosters. The post-bid build/optimization process can improve the solution to some extent, e.g. by working open time trips into the solution and through global trip swap optimization, but the initial build and preference parameters have been adjusted by the crew themselves to fit together with minimal conflict.

No matter what post-bid build/optimize process is in place, an improved solution will be obtained over a non-interactive process due to the crew-approved parameter optimization that occurs during the interactive bidding process.

What Information Would I Like When Entering My PBS Bid?

BIDDING PERIOD OPENS

	SmartPref PBS	Conventional PBS
When a trip combination is illegal	Always	No
When a bid is infeasible	Always	No
When a global constraint (vertical, horizontal or time stack) is in effect	Always	No
Days on which I will be forced to work due to stack / "juniority"	Always	No
Ability to simulate / enter different bids	Always	No
Ability to adjust / change bids after seeing results	Always	No
Ability to switch bid for either a hard line or a reserve line based on days off	Always	No
What trips are available at my seniority level	Always	No
What days off remain available at my seniority level	Always	No
Did I bid enough trips or enough credit / block time	Always	No
Did I bid too generic / too optimistic	Always	No
In a high line average month, what will be the impact on my bid/line	Always	No
If I waive credit of any kind, what will be the impact on my bid/line	Always	No
If I slide my vacation, what impact will it have on my bid/line	Always	No
What impact will training (or any other absence) have on my bid/line	Always	No
If something in my private life changes during the bid period window and necessitates a different bid, what would be the impact on my line	Always	No
What are the parameters / rules in effect for this run	Always	No

BID PERIOD IS CLOSED / BID RESULTS POSTED

	SmartPref PBS	Conventional PBS
When a trip combination is illegal	Always	Yes, but too late to help
When a bid is infeasible	Always	Yes, but too late to help
When a global constraint (vertical, horizontal or time stack) is in effect	Always	Yes, but too late to help
Days on which I will be forced to work due to stack / "juniority"	Always	Yes, but too late to help
Ability to simulate / enter different bids	Always	Yes, but too late to help
Ability to adjust / change bids after seeing results	Always	Yes, but too late to help
Ability to switch bid for either a hard line or a reserve line based on days off	Always	Yes, but too late to help
What trips are available at my seniority level	Always	Yes, but too late to help
What days off remain available at my seniority level	Always	Yes, but too late to help
Did I bid enough trips or enough credit / block time	Always	Yes, but too late to help
Did I bid too generic / too optimistic	Always	Yes, but too late to help
In a high line average month, what will be the impact on my bid/line	Always	Yes, but too late to help
If I waive credit of any kind, what will be the impact on my bid/line	Always	Yes, but too late to help
If I slide my vacation, what impact will it have on my bid/line	Always	Yes, but too late to help
What impact will training (or any other absence) have on my bid/line	Always	Yes, but too late to help
If something in my private life changes during the bid period window and necessitates a different bid, what would be the impact on my line	Always	Yes, but too late to help
What are the parameters / rules in effect for this run	Always	Yes, but too late to help

All the information the SmartPref bidder requires is revealed before the line is awarded - Not true with Conventional PBS

Bidding Late - What Happens?

#1 Bidder Changes His Bid At The Last Minute

Scenario and assumptions:

- 100 captains bidding for an average line of 75 credit hours for total credit hours of 7,500.
- 1,000 pairing operations (one and two-day trips), worth an average of 5 hours credit per duty period make up the 7,500 hours.
- Average captain works 15 days and flies 10 trips.
- Bid results are final when the bidding window is closed.

1 Captain logs in at the last minute and changes his bid. What Happens?

Before describing the affects of a late bid by a senior crewmember, let's review the following:

- 1) Unlike bidding on EBay, there is absolutely no benefit in bidding at the last minute.
- 2) The pilot group will obtain better personal results when everyone participates. The corollary to this is that a crewmember who does not participate hurts himself and his fellow crewmembers in that their inventory of days off and trips will be somewhat unrealistic.
- 3) With the exception of the #1 bidding crewmember, all other crewmembers depend on those more senior to them.
- 4) SmartPref has unique and sophisticated combinatorial and substitution logic that allows the crewmember to bid for a range of preferences that are always being considered. True the bid results of the crewmember will improve or be degraded based on how senior crewmember bid, but this employed logic makes a last minute bid change relatively harmless.
- 5) Crewmembers have global access to the system 24/7/365 – there is no reason to bid late. In practice, spouses / significant others/ designated assistants can always bid for crewmembers.
- 6) This is the Internet – all activity is tracked. If specific crewmembers make a point of not participating in the system by bidding late, this information is available to your ALPA committees and the Chief Pilot, as desired.

Let's review what happens when the senior captain drastically changes his bid at the last minute. This might be a complete change of requested days off and/or trip type.

Captain #2

Assume the #2 captain wanted ORD layovers on Mondays and Wednesdays and now this is what the #1 captain wants. Seniority prevails and #2 will get his second choices, which will have been bid.

Captain #25

If the #1 captain gave up "good" trips that were once on his line, these "good" trips, now available, were probably awarded to pilots senior to #25 who wanted them. However, even though these specific "good" trips were not available to #25, other "good" trips that the #25 captain couldn't hold before have now become available. Bottom line, his bid improves.

If the #1 captain had not even bid and his Standby bid awarded him “bad” trips and he now bids for the “good” trips, there would be a filtering up of the “good” trips as “good” trips rise to the top. So if the #25 captain had bid for layovers in ORD, DFW, PBI, FLL and SFO in that preference order and was currently holding a mix of PBI and ORD layovers before the #1 captain changed his bid, then #25 would lose the ORD trips and maybe even the PBI if it was desired senior to him. He would then be awarded DFW, FLL or SFOs based on his preferences. Again, SmartPref’s substitution and combinatorial logic means that the pilot will always receive the best possible line of time as trip inventory changes.

At #25, numerically 760 trips remain to build his line and he will still get his desired days off. Life, as this pilot knows it, will not end. If he had bid for trips departing early in the morning and the #1 captain claimed 10 early morning trips, then the line for #25 might change to include trips departing a little later in the morning, again all based on his bid.

Captain #50

By this level, the character of the line award for the #50 captain remains essentially unchanged. If the pilot had bid for specific days off, he will most likely continue to have those days off (500 trips remain). If the pilot had bid for specific trips, those trips might be gone but if the pilot, as recommended, had also bid generically (i.e., desired trip length, departure time, return time, layover, etc.), the pilot would probably see no measurable difference in his line award. There is the possibility that his bid result may improve slightly or degrade slightly.

Captain #75

The same things that were said about Captain #50 can be said about Captain #75 with the exception that if Captain #1 changed his desired days off from, say, December 10-15 to wanting December 22-28, then two things may happen. If Captain #75 had bid for Christmas off, then Captain #75 may not get Christmas off now. However if Captain #75 had bid for Dec 10-15th off, Captain 75 may get these desired days off whereas before he did not.

Captain #100

At this point, 990 out of 1,000 trips have been awarded – 10 trips are left and all are required to make a legal line. The reality is that the quality and operating days of the remaining 10 trips are probably the same as before. He should see no difference in the sense that the ripple caused by the change in the #1 bidder will have been sorted out by the time he is served.

Why this works:

Behind the scenes there are two computers working – one computer is handling the bidding interaction with the pilots and the other computer is continuously running the batch solution. In the Sun Country environment, SmartPref takes approximately 5 minutes to generate the PBS solution for 160 pilots. The results of this batch run are moved into the on-line environment accessed by the pilots. Over the course of a seven day bidding window, the online solution will be updated 2,016 times.

Let’s assume towards the end of the bidding window that bidder 5 and bidder 50 are online and, secondly, they both bid exactly for the same trips. What happens is that bidder 5 gets his award (no message) and bidder 50 gets the same award BUT with the message that his award is tentative and not final. Within seconds, Bidder 50

will see his bid result change (because bidder 5 got the trips) and now sees the message that his result is final. In the background, SmartPref has rebuilt the lines of the on-line bidders. The next question is what if bidder #6 (who is not online) wanted one of the trips that came from bidder #5's old line? This is resolved in the batch computer process that is continuously rebuilding ALL of the lines using each bidder's most current bid. This solution is moved to the online environment and if the bidding window is over, this result is the final result.

Other options that can be customized for your airline are:

- Extended bid period windows.
- Staggered bid closings based on levels of seniority (top third, middle third, etc.).
- An initial bidding close date for all. However if there is an inordinate amount of last minute bidding by senior bidders, then a reopening the bidding window for the bottom of the seniority list (i.e., bottom 25%) to continue bidding for some additional time period.

Lastly, we feel after using SmartPref and understanding its strengths and differences, bidders will not delay in bidding. They will be more inclined to finish early knowing their possible schedule can be solidified that much earlier in the month.

Solving the PBS Problem - An Overview

The goal of PBS is to assemble a set of crew rosters (lines) that satisfies all roster constraints (e.g. no conflicts, credit within min/max bounds, minimal unassigned trips) and at the same time maximizes crew satisfaction, and respects crew seniority.

LP Approach

In order to model the problem in a way that reveals its linear structure susceptible to LP (linear programming) and IP (integer programming) solution methods, a choice set of scheduling objects must be defined from which the optimum solution may be extracted using linear programming techniques. The scheduling object is an individual 'line' assigned to a crewmember, i.e. the assignment of dated activities to the scheduling period for a single crew member.

Assembling a choice set of these lines from which a solution can be extracted using linear methods is the first step. To this end, LP assigns a unique cost to each such line, and expresses line constraints such that they can be modeled linearly.

Herein lays the problem. The size of the choice set is far too large to be subjected to LP methods. If one attempts to reduce the size of the choice set in some intelligent manner to some small and manageable subset, one runs the risk of missing the optimal solution akin to throwing the baby out with the bath water. Examples of this are seniority inversions or bid results that clearly could be better. Reducing the size of the choice set always leads away from the optimal solution unless, of course, that subset contains an optimal solution to the larger choice set.

In addition to the size of the choice set, the other problem is the selection of the choice set itself. Column generation provides a method for including or excluding new lines into an evolving choice set - lines which will improve the optimal solution and that may be extracted from each successive choice set. However, there is no straightforward way to decide how best to add new candidates to the choice set. Obviously if the wrong ones are added, there will be little or no improvement, and this could occur over and over until the choice set is too big to solve with LP methods. Hence the long run times common to LP line builders.

In the case of crew pairing optimization, very good results have been obtained using LP, but the lines problem differs substantially from the pairing problem in that there are many more combinations of lines which are of comparable quality and therefore subject to being selected. In the case of pairings a minor variation (a different flight segment) will generally result in a change of cost whereas in the lines problem there can be literally millions of lines that will satisfy a given criteria (e.g. all the lines that have between 72 and 80 hrs of credit and have all Wednesdays off).

Heuristic Approach

The weaknesses (the huge size of the choice set and determining the right choice set) of using LP to solve this type of problem suggests that solutions using heuristic methods, which combine the simpler component scheduling objects, i.e. trips, will arrive more quickly and with very good if not near optimal results. This is the approach that Crewing Solutions has taken.

LP engines work with entire *lines* as their basic scheduling objects and creates choice sets from which a solution is extracted. If the solution is to be optimal, it implies that the set of lines that constitute the optimal solution will be found in the so called choice set. Clearly if all possible lines were included the set, the extraction will produce *the* optimal solution. But as we know the numbers of possibilities are far too large to come even close to this. By taking trips as scheduling objects and limiting the number of possible combinations to a single line at a time we arrive much faster at a better solution. The process is detailed below.

The SmartPref Engine

Every eligible crewmember has a bid which translates into a bid matrix, an ordering of all the available trips in the sequence that will be submitted to a line builder from which an 'ordinal' line will be extracted. As the name indicates, the ordinal line is the result of adding to a line the trips in the order they were rated by the bidder. The ordinal line may be successful (within the stipulated limits of utilization) or not. If successful, it is retained as the first line in the possible line choices for the bid; otherwise the line builder generates 'optimized' lines. Optimized lines are derived by recombining or rearranging trip selection so as to insure completeness and maximum satisfaction. The recombination uses substitution algorithms subject to global constraints that are very fast and exhaustive within the bounds set by the ordinal line and its successive improvements and a user-defined parameter. Often an ordinal line cannot be improved and the best optimized line is then the ordinal line. Throughout the building process the awarding of trips is controlled by a 'stack control' that ensures that the remaining open time (unassigned trips) can be distributed among the remaining bidders within the stipulated utilization bounds. The stack control, by determining criticality, allows the builder to proceed very quickly at senior levels where there is no criticality. Thus for example, in a problem size of 600 lines, 450 lines are non critical and are generated very quickly. When criticality is determined to be present, the solution time increases dramatically but the problem has now been reduced to 150 from 600.

Criticality is declared either because within a time interval there are more assignments to be covered than there are crew members available (vertical criticality), or the remaining lines cannot be built within the global constraints, e.g. min/max utilization range (horizontal criticality). In the case of vertical criticality only the time slice concerned needs to be resolved; when the trips have been allocated a choice optimization is performed to maximize preferences within seniority. Vertical criticality may be present many times at many different seniority levels for different time intervals. When horizontal criticality is detected, ALL the remaining open trips are assigned and again a choice optimization is performed.

Although the above is a simplification of the SmartPref heuristics, it gives the flavor of how a line is arrived at using trip-oriented manipulations, so that the complexity and number of possible lines is kept manageably small, and yet the twin objectives of achieving feasibility and optimizing cost and preference is attained.

The Added Advantages of Interactive Bidding

Non-interactive PBS systems require that all crewmembers submit their preferences without reference to the preferences of other crew members. These static preferences are then fed into the PBS builder/optimizer in the form of seniority and preference parameters which are then used to generate a global "assigned lines" solution. While non-interactive systems do utilize crew preference data to generate a global solution, they cannot avoid solution defects that arise from inevitable "clashes in preferences" which are characterized by sets of preferences for different crew members that would encourage the assignment of the same trip to two or more crew. Such preference clashes are symptomatic of non-interactive bid systems.

In contrast, an interactive PBS has the potential to accomplish parameter optimization as part of the interactive process itself: when a bidder recognizes that his original preferences lead to an undesirable line of time, he adjusts his preferences until the line is to his liking. The bidder's ability to adjust his preferences is thus the first advantage of the interactive PBS. The second, and complementary, advantage of interactive bidding is that it utilizes up-to-the-minute bidding information from other bidders to allow the crewmember to know what his possibilities are most likely to be under various bid scenarios. (In contrast, a non-interactive bidder has no information as to what the likely outcome of his bid will be: he is bidding blind.)

But the most important and significant advantage of an interactive PBS is that it is the bidders themselves that are dictating the shape of the solution that will be eventually be derived and the bidders, by minimizing non-feasible situations, reduce the resolution time further.

Summary:

The Crewing Solutions' SmartPref Preferential Bidding System was described and compared with line builders using column generation methods. Column generation is found to be a very powerful method for solving very large combinatorial optimization problems, such as the airline crew pairing problem, but suffers from the huge size of the problem dictated by the minimum size of the scheduling objects required for the use of column generation and other linear optimization methods. The use of interactive bid adjustment, seniority ordering, and build heuristics which depend on much simpler and less numerous scheduling objects, SmartPref permits the creation of high quality line solutions in a fraction of the time required by linear methods.

A SmartPref Way – A Bidding Parody

Once upon a time a vendor presented to pilots and management a new and innovative way to enhance pilot quality of life by changing the way they constructed their monthly PBS schedules. As the presentation unfolded the pilots became incensed because they believed that the company was clearly trying to take something away. The pilots could see that this new method for building their schedules, even though being presented as new and innovative, was in fact restrictive, archaic and really made no sense at all.

The vendor representative presented a new BATCH Preferential Bidding System that would replace their current INTERACTIVE Preferential Bidding System. Pilots had been very pleased with their INTERACTIVE Preferential Bidding System because it allowed them to modify their bids during the bidding window to explore different scenarios, evaluate the trip tradeoffs required to get desired days off, and to understand why they were forced to work certain days and/or be denied certain days off. It was an open environment, a marketplace where clarity, current information and logic ruled.

The vendor representative said that the new BATCH process would eliminate the hassle of interacting with the computer because the pilot would have to enter his bid just once, the computer would run all the bids at the same time after bid closing, and the result of his bid would be final. No more time wasted modifying your bid to get exactly what you want.

One pilot asked “how would I know if I bid legally under this new system and wouldn’t I run the risk of having my bid tossed out if it were illegal?” Another pilot stood up and asked “how would I know if I underbid or failed to bid for the best possible schedule?” Under the current system, the pilot continued, “I have the ability to enter a bid and get immediate results back and thus evaluate multiple alternative bidding strategies”. A third pilot asked “how would I know why I got a trip I didn’t ask for or failed to get a desired day off?” All good questions the vendor representative responded and the answer is simple – the reason report. This reason report tells you if a trip was awarded senior to you and, if the trip was available to you that global constraints applied and thus you couldn’t have it anyway. Nothing could be simpler or more straightforward said the vendor.

The pilot responded with disgust “What good is a reasons report if I can’t adjust my bid as a result of this knowledge”. The vendor gleefully responded, “That’s the beauty of this new BATCH system; you don’t really need reasons, you only need trust in the computer.”

The pilot group left the meeting unimpressed with this new BATCH preferential bidding system and resolved to keep the flexibility and control they had currently with their INTERACTIVE and real time preferential bidding system.