Blues Skies Podcast
Season 1, Episode 47

Test flying the LCA - with Cmde Jaideep Maolankar

PR Ganapathy:
Hello, and welcome to the Blue Skies Podcast. I'm PR Ganapathy, your host.

We are continuing our conversation with Commodore Jaideep Maolankar, and today we're going to spend all our time really discussing the light combat aircraft, both the Tejas, as well as the Navy LCA. So welcome back to the program, sir.

Cmde Maolankar:
Thank you.

Ganapathy:
So, you know, you had mentioned your initial contact with the LCA was when that fat dossier landed on your table in the ship, over 700 pages of the design document for the Navy LCA. But how did you reengage with the program, and how did that journey begin with the LCA testing?

Cmde Maolankar:
So around 2005, I had pretty much finished with my mandatory QRs as a commander in the Navy. I had done my flight commander’s tenure, followed by a Squadron command, and then I had moved on and done a frigate. I had commanded a frigate for also a year. So that's about the time when they start pulling you out for giving back to the Navy and make you do staff jobs.

So all the fun jobs are over, and now the hard work starts. So I was quite pretty terrified about that. And I kind of kept touch with kept track of where the LCA was going and what little bit of news used to come out occasionally once in a while, but it was pretty much deadly fear of being stuck behind a desk, which is when this thing came about that that's about the time when NFTC was also being asked to start providing inputs and feedback for the LCA Navy program.

Ganapathy:
NFTC for the audience who don't know, it's the National Flight Test Centre, right?

Cmde Maolankar:
Yeah. So they figured that it's the right time to induct a Navy pilot.

I'm not sure whether it originated from NFTC or it originated from Naval headquarters, but whatever between the two of them, they got together and decided that they would. So I was, again, as usual, asked to volunteer, which I pretended to do very reluctantly, but I was completely thrilled to have that opportunity.

I'm not sure I really knew what NFTC was all about or what I was getting into. Frankly, I had no clue how much fun or how interesting the program is going to be. It was just a very selfish reason of avoiding staff work. And frankly, this is the only way in which I could continue flying, because beyond Squadron command, there really is you can only do some token flying, the notional or nominal kind. This sounded very interesting for that reason.

PR Ganapathy:
And which year was that? What stage was the program at?

Cmde Maolankar:
So this is 2005. I joined in August 2005, and at that stage, the LCA Navy was still far away. It had not even been rolled out, for that matter. And the LCA program itself was in its infancy. I think when I joined, they had done about, if I'm not wrong, close to 200 odd sorties. We were pretty early in the program. We were flying TD1, TD2 and PV1 was the new aircraft, in the sense that you have to be briefed specifically about its differences and things like that. But primarily, it was TD1, TD2, that's the stage. We had gone supersonic. But the envelope was pretty restricted. Still, G was restricted. Controls were fairly basic. I mean, you couldn't even do loops, as I discovered, to my horror.

PR Ganapathy:
Okay. And just for the audience who are not familiar with these terms, what is TD One? What is PV One? And what is the envelope when they talk about an aircraft envelope?

Cmde Maolankar:
So the LCA program actually is a composite of what you see. The LCA that you see in the Squadron is actually already iterated and modified version of what was the original first aircraft that flew, which was Technology Demonstrator One. So actually, the program was initially run as a technology demonstration program called FSED Phase One, Full Scale Engineering Development, phase One, which was supposed to be two aircraft, and they added a third aircraft called PV One, within the same funds.

These aircraft were with the old standard G 404 engine that's the hydromechanical fuel controls. It had rudimentary kind of electronic controls only for the reheat portion, not for the basic engine was still hydromechanical control, which means mechanical linkage from the throttle in the cockpit to the FCU, et cetera. The cockpit was of the older standard in the sense we had two MFDs, we had the older standard mission computer, the older standard HUD [Head-Up Display], a few, I would say, odd looking standby instruments. And it was primarily intended to prove out the basic technologies. The other major differences on those aircraft were that they had a wing originally designed for the R 60 missile. So this aircraft was designed something along the lines of the MiG-21 Type 77, wherein the two air to air missiles was considered to be the standard fit.

So everything, everything of the aircraft was to be done with those two missiles to the extent that you could not even fly without the two launchers. That's the net result. You can't really have an absolutely clean LCA. The advantage, of course, is that whatever figures get quoted, whatever demonstrations are done, too, they are in a more realistic usable config.

The wing was the older standard wing. Like I said, the engine was the older standard engine, and I would think even the fuselage was much more metal. The wings were pretty much the same, barring the fact that they were not strengthened for the R 73. Of course, many other details in the system subsystems. It didn't have the pre cooler for the environment control system, that is an additional cooler for the air just as it comes out of the engine. It didn't have that.

So in that sense, it was substantially a different aircraft. And these were to be used for the initial validation of these new technologies. These four major technologies, which are supposed to be the pillars defining the LCA program that is carbon fibre composite, primary structures, digital fly-by-wire, glass cockpit… and what was the fourth? multipressor controlled, very archaic language, multi processor controlled systems, that is software controlled, even utility systems being of that.

So these are kind of the basic kind of definition of a fourth Gen aircraft. And that's what the aircraft is supposed to do. PV1. So that's the first two aircraft - Technology Demonstrator One and Technology Demonstrator Two. And then there was PV One, which is Prototype Vehicle One, which was originally intended to house the Kaveri engine. So it had a bigger intake and things like a different little bit of different boat tail, I think, since that did not fructify in time, so it was backward modified again to fit the GE-404 engine.

And since it had bigger intake. So they kind of fitted a spill door to spill the excess air. But it still retained several limitations, additional limitations originating from this reverse modification to make it backward compatible again to the 404.

So that's what the three aircraft which were in the program at that stage.

PR Ganapathy:
This was before the full scale, the limited series production.

Cmde Maolankar:
This is before that, then this is well before the limited series production. So because after that, we had another tranche of what we call PVs, that is PV2 and PV3. PV5, that's the trainer. That's a separate line. But in the Tejas stable. There was one more layer in the middle, which was PV2 and PV3, which were trying to get them up to an operational standard, that is, a strengthened wing. Because the Air Force had decided to change the primary armament to the R-73. And of course, fitting some sensors, the Avionics was upgraded to an open architecture mission computer, three MFDS, zero electromechanical instruments in the cockpit. So even the backup instrumentation and change pretty much the cockpit that you see now, that cockpit standard or that Avionic standard. The cockpit still

underwent many iterations. But that Avionic standard was pretty much what came in with PV2 and PV3.

And then the next gen was the LSPs. Now, this has been one of the things of the LCA program that we have had to introduce all the constituents of the final aircraft that's in all the sensors, the helmet, the radar, the EW, the pods, the weapons, all the external stores, for that matter, they have all been introduced progressively.

So although I think the LSPs were originally intended, they were termed LSP because they were originally intended that they could actually be re-instrumented and used as in service aircraft. But as it turned out, they are all prototypes in all but name. Because each one had some incremental standard.

The other big thing was that because we did not do full envelope on the TDs or the PVs. Therefore, many changes came in late in the program. And therefore, the LSP also incorporated several structural, mechanical kind of changes. Also that was also something which was progressively built up over the LSPs. So although they were termed LSP, I think the only real change was that they were built by Aircraft Division rather than the ARDC. Even within HAL, they have these divisions which are almost like corporate behemoths. Each division itself is pretty large, but the prototypes are supposed to be built by ARDC. They're a little more hand built, not using the production jigs and things like that. But the LSPs were built in a facility which was more akin to the production centre. That was about the only real change, apart from the fact, of course, that each LSP literally had some incremental, some major incremental updates like a radar or the helmet or strengthened stations for some of the stores as it became evident that this particular store is going to need some strengthening. So that kind of mods. Every LSP is pretty much unique. I would think that for any specific capability, there would be typically not more than two aircraft of the right standard. I'm talking about within the LSP thing.

This is, of course, what is needed to get everything together, because the final production aircraft has to have everything because in service the squadron needs all its aircraft to be of identical standard, at least similar, if not identical, but at least similar. So maybe it was just this naivete of fleshing out or scoping out a program with just two and three prototypes, although it constitutes an overrun. Actually, if you look at it in the big picture, it's pretty much par for the course. The overall number of aircraft that have been used is pretty much par for the course. It's not really any different from anywhere else in the world. It's just that because we artificially, I think we are pretty arrogant. Technically, we are pretty arrogant. We really think that we are so much more than the rest of the world. But yeah, it's pretty much we've done pretty much the global standard.

PR Ganapathy:
And so initially you were involved with the envelope expansion for the Tejas… what are some of the things that you did there?

Cmde Maolankar: [15:49]0
So I mean, the aircraft for its operationalization, first of all, its basics needed to be done.

That means it's envelope needed to be finished. And I'm talking about the high speed end of the envelope, the supersonic portion, the high Alpha portion, the high G portion. So these were the primary elements of the envelope.

There are, of course, other aspects of the envelope. Also in terms of whether you look at it in terms of environment that is flying through rain, landing on wet runways, cross wind, there are many, such as the engine distortion envelope. That means it's tolerance of adverse flight conditions, et cetera. So there are many elements, many aspects of the combinations of parameters that an aircraft can face which need to be tested out. I mean, our test pilots should always see any combination first, any combination that is possible. A test pilot should see it first before a squadron pilot ends up seeing it. So that is what we call as opening up the envelope or expansion of the envelope, whatever terminology you use.

PR Ganapathy:
You've done some interesting work on the high AOA or high angle of attack / high Alpha regime, and as well as on the flutter, the speed portion, particularly this negative SEP at low altitude. So it sounds like a very scary thing. I'd love for you to just explain this in layman terms. What did high Alpha testing involved? How do you go about it?

Cmde Maolankar:
Chronologically, we did speed first and Alpha, then we did G, so that's how it kind of panned out. So flutter. So I think maybe we'll do it in that order also. Probably actually flutter. The flutter story for me really starts from LUSH, which is the limited upgrade of the Sea Harrier.

And what happened was as I joined NFTC is also when the Navy wanted to do LUSH. So the first two odd years I was doing half and half, so I'm not sure I did very much. I mean, I flew the LCA, but I didn't really take primary responsibility for any of the major tasks because I was in and out of Goa some of the time doing LUSH.

It's a bit of a digression, but it kind of builds into the LCA envelope. So if it's okay, I'll talk about that. So LUSH was a complete program in terms of sensor upgrade, addition of a radar or data link, new displays, and a new missile on the Harrier. The integration was done primarily by IAI. The flight test was the responsibility of IAI, with only the ground servicing crew, the aircraft, of course, the ground servicing crew, and the flight crew to be provided by the Navy. So that program I kind of did… with all the FTEs were IAI, the telemetry was manned by IAI, the flight test planning was done between them and me. Flight team was a grand total of me at that stage.

So even though it was a two aircraft program and it was a data-link program, so I had really struggled to explain to people that I can't fly two aircraft and if you can’t fly two aircraft simultaneously you can’t prove the datalink.

But the aeromechanical part of that was interesting because we were doing it without participation of the OEM. So it was a full regression program. That means you take the existing aircraft and understand it completely and then add on these new stores, that is the new missile, Derby missile, and the new radar with a new radome. Add on these two and then see what the changes you made with the hope of retaining the original flight over capability of the aircraft.

So, they laser-scanned the aircraft, they recreated the aerodynamics through CFD. CFD is probably good enough for evaluating changes. So there were basically two things. One was the fact that we use CFD, which is reasonably okay for evaluating changes. And the second major thing that somehow I had the wisdom to insist on, was that we would not change the stability of the aircraft in terms of centre of gravity. So the new missiles were all made to match the original Magic missile, for example. So we made sure that we match that. So we didn't disturb that. Because the Harrier is particularly sensitive to CG variations while hovering, et cetera.

And the second major thing that was an act of great wisdom, frankly, at the end of it was not to change the shape of the Radome. So it was tempting to go the way of the F-18, which has a more bulbous radome. So that you could house a bigger antenna, more power, better radar performance, et cetera. But that had caused a lot of trouble. With engine surge margin on the F-18 program also. So I didn't want the Navy to get into that part of the envelope at all. Or working around engine. Because that was clearly even beyond IAI's capability or their skill set. So we said, let's avoid that. So we stuck to these two things. And that really helped to make the program really clean. And it just went through beautifully. It was a very nice integration.

So one of the major things that we introduced in that program. Was the use of air refuelling, for speeding up the flutter program significantly. Now, it's been used the world over. But in India, we've never used air to air fueling as a support infrastructure or facility for flight test. In order to speed up flight test. So they insisted that no, why don't you? Since the Harrier is capable of air to air refuelling. The Flutter program will go on forever if you don't use air to air refuelling. And we just followed them. When I asked, and I was very surprised to find that I was given as much air to air refuelling as I asked for.

PR Ganapathy:
So these were Air Force assets?

Cmde Maolankar: [23:15]
Yes, these were Air Force assets. An IL-78 used to come down. In fact, we brought the Harrier from Goa down to Bangalore. Because it was in the monsoon. Goa monsoon is not something worth trying to do flight testing in. So we brought it down to Bangalore. And the Tanker would come down and Bangalore LFA, I had the pleasure of flying four and a half or 5 hours, seven, eight refuelings each time. Because all you're doing was plug in quickly, get to the height and speed combination that you want. And go right back and plug in. Or rather, wait till the Flutter analysis is done by the Telemetry crew. And when they tell you it's good to go. Then you plug in again, quickly fuel up and go right again. So when you realize that the fuel quantity of the aircraft also makes a significant difference to the flatter characteristics. So you need to be as close to full as possible. Because those are normally typically the more problematic configs. The heavier ones with more fuel in them, more inertia that is. So I even ended up taking the tanker up for really nice and high. I mean, even tanking is normally done

in a preferably in a fairly restricted kind of envelope speed, as well as altitude. We don't really like to go too low or too high, but because we wanted to get to those heights and speed with as much fuel as possible. So we needed to unplug from the tanker as close to that as possible. So we couldn't really do too much of the speed. But I could take the tanker up and then you start hitting. You're actually sometimes literally falling off the tanker because as you fill up, you need more and more power to keep up with the tanker and you're pushing that drogue. Also, you're carrying the drag of that drogue on the aircraft which is receiving the fuel. So you find that when it gets too much, you just literally you're at full throttle and just gradually just falls off the falls of the tanker and unplugs. So that becomes the natural kind of limit.

But with all of this, what ended up happening was that I actually ended up having to study flutter very deeply because you were doing it literally in real time. Each incremental step was in real time, literally every ten minutes. You were doing the next speed and height combination.

PR Ganapathy:
Right. So I'm still struggling to get my head around what flutter is. A few other people have tried to explain it, but I'd love to hear your explanation, especially for the layperson.

Cmde Maolankar:
So flutter is, I mean, if you just think of it, you hold a sheet of paper from one end and just put on the fan and you find that the sheet of paper starts fluttering, literally fluttering. Right. So that pretty much is something which any aerodynamic structure will do or will have a tendency to do, unless there is a proper design which makes it, which makes it resistant to it.

Now, why does the paper do it with just a gentle breeze coming out of a fan? Because it's got extreme flexibility in it. So clearly the elasticity, the resistance of that structure to being deformed is clearly one of the forces. The aerodynamic forces are clearly where the energy is being drawn from. I mean, there has to be a transfer of energy from the original source into this flapping, fluttering movement. That is the energy transfer is the real problem and that's the mechanism which needs to be studied. So it's a balance of the inertial forces. That is the masses, the way these masses are pivoted and the way they flex. In terms of, let's say, a swept wing design or a Delta wing design or a straight wing design, you can imagine that even if the wing is the same. But if I just keep changing the sweep angle, it will tend to move differently when I look at it as an elastic structure, because if CG has shifted aft of the point where I'm holding it, the point about which it would tend to pivot. So it's a combination of these inertial forces of that structure. How does the lift change when it moves under load? How does the lift change? Does it increase? Does it remain the same? The combination of these two is very simple to visualise. When you think of these simple things of a paper fluttering, it's a lot more complex when you actually try and do it analytically. And in fact, that is probably the defining aspect of the hazard out of flutter. Unlike many of the other aeronautical science disciplines, this is one of the most inexact Sciences. I would say lifeing[?] and flutter are the two inexact Sciences. In Aeronautics, everything else is amenable to good, strong analysis. You throw a lot more computing at it. You throw a lot of brain power at it, and you can be pretty good at predicting what is going to happen, which means you can design and be sure that it's going to behave as you expected, and therefore, even testing it becomes relatively easy. You just need to… in quick jumps. You can cover the full envelope that is intended…

PR Ganapathy:
Because you're just validating.

Cmde Maolankar:
Right, you're just validating. Flutter is not like that, although all the scientists who work on neuro-elasticity will be very upset, but I say this all the time, so it's not something new, and this is pretty much the way it is.

PR Ganapathy:
And do you experience flutter as a pilot, or is it just picked up by the sensors? No. I mean, what's the danger when it's uncontrolled?

Cmde Maolankar: [30:07]
If flutter occurs, you're probably going to break up the aircraft. It's that straightforward. So the thing is that when the structure starts flapping now, if it is an extremely flexible structure, like a piece of paper, it's okay. But typical aircraft structures will not tolerate that kind of movement, and they will literally break the aircraft apart because the structure cannot be designed for taking that kind of motion and loads. So the problem with flutter is that it sets in quite often, explosively. Very suddenly it will set in. That means the structure is damped… the thing is that any disturbance, any turbulence in the air, can also set up an oscillation in the aerodynamic surfaces, which, if this combination of all these flutter forces is not favourable, will tend to aggravate this motion, and then it builds up and it will just snap off these surfaces. So this sets in fairly rapidly. Hard to just simply by looking at the behaviour of the aircraft, it's very hard to tell whether you are getting close to a limit or not. The only way you can do it is if you can see how disturbances are being damped out. Disturbances tend to get damped out when the structure, when the whole system is stable. If you have flutter modes, which are gradual in their onset, then you will see a gradual decay in the damping. And when the damping drops too low is when you will have flutter. This is one of the assumptions on which a lot of flutter work is based. However, there can be anomalies in the structural behaviour or even in the aerodynamic behaviour. You can have one set of wattles, you can have onsets of separations which have not been predicted in the analysis, and therefore, your analysis is not showing the sudden changes in behaviour. And you can even have fairly explosive onset of flutter. And paradoxically, you can even have scenarios where you find that the damping is increasing and then suddenly falls off. So the point being that with flutter you are really feeling your way towards opening the envelope. And the way I finally rationalised it in my own head was that any deviation from the expectation is a cause for concern. It's not just a drop in the damping when the damping gets too low, which is a cause of concern. But even an unexplained increase in damping can be a cause of concern because that can be a warning that things are not as you think they are or as you expect them to be, and therefore be cautious.

PR Ganapathy:
And you're instrumented to measure the damping, or is that being telemetered and then communicated?

Cmde Maolankar: [33:34]
So there are various methods of doing it. The most typical method nowadays with fly-by-wire aircraft, et cetera, is you inject disturbances through the control surfaces. That means you have these automated routines in the software which you inject them over and above what is being demanded by the pilot or by the normal flight fly-by-wire software. Over and above that, you introduce a little frequency sweep on the control surfaces. High frequency. I mean, you're talking about a few Hertz, going up to a few tens of Hertz. At that rate, you move the aerodynamic control surfaces, so that introduces disturbance into the thing and then you stop it and then you see, how does the disturbance decay? How does the structure damp out those disturbances? That's one way of doing it.

The other way of doing it is you use the disturbances that occur from the natural air turbulence. So you inject this or you take it into an area where there is some amount of turbulence so that there is some upsetting, and then you are basically tracked. You basically have these vibration sensors all over the aircraft and you are tracking how are those sensors, the traces coming out of those sensors.

So it's a little difficult to explain without moving my hands around and being able to draw on a whiteboard. But yeah, this is pretty much it. Now, you need to obviously do a fourier analysis of the vibration sensors, look at frequency modes, each mode, if you have seen, there used to be this toy which a lot of these hawkers would sell. It's a bird with two wings, it's got a wooden body and two wings, which are hinged. And it is suspended through strings from the wings. And when you move it, the whole body of the word goes up and down and the wings kind of flap. So that is the way you can visualise some of these motions. So every aircraft has multiple modes in which it naturally wants to flap. So one of those modes is something like what that bird would do that is actually close to the second wing bending mode, wherein you're looking at as if you hold an aircraft up by two fingers, one under each wing, and you just push down on the body and leave it how the body would bounce up and down and the wings would flex around with these two nodes fulcrums where you're holding it up. The first bending mode would be just the wing by itself. You will just hold the body of the aircraft and just tap on the wing. And how would the wing flap and sort itself out? So like that. There is basically any major aeroelastic element of the aircraft, the fuselage or wing or tail fin. Each one of these things has unique behaviour or unique influence. The composite of all of this is what makes the aircraft behave the way it does. So you can have one particular flutter mode by itself getting into trouble. You can have two different modes. That means two different types of motion tending to synchronise and thereby suddenly adding energy. That's where the explosive element comes in. As long as they are at different frequencies, they are by themselves. Individually, they are all damped. But because their frequencies are slowly changing, when the frequencies coincide, you can have a sudden explosive change in the damping. And each mode is adding or aggravating the other. You could have some mode serving as an energy transfer mechanism between one mode and the other. It's a black art, let me put it that way. There is, of course, sufficient scientific rigour in it. But it's not sufficient to guarantee that the aircraft is going to behave the way you expect it to behave.

Which basically for flight test, amounts to what? It means: (a) you have to flight test. You cannot release to service anything that you have not physically tested. You can't release an envelope to service by just by analysis. So if the aircraft has been designed for a speed envelope, which is, say, thousand knots or something like that, indicated air speed. Now, even if that aircraft cannot suppose that aircraft cannot achieve thousand knots. Even if you take her to the ceiling and put her into a vertical dive. And even if the terminal velocity is not 1000 knots, then you can't write 1000 knots in the manual. Even though you are completely convinced that the aircraft is capable of flutter free flight up to 1000 knots. You can only write what you have actually taken it up to. So if you've taken it up to 900, then 900. That's the speed envelope of the aircraft. It's fine because you can't really exceed it. Although someday somebody will find a way of doing that. So one, you have to flight test.

Second is, when you are doing flight tests, you can expect to see variations, surprises as compared to what was expected. So this is one element of flight testing where skill is not something that can keep you safe. Because there is no skill in which skill set you can acquire or which you can prepare yourself to say, I will fly her out of that flutter envelope. The skill, or the knowledge is, in a very controlled, calibrated manner, putting the aircraft into those intended test conditions without infringing something else. And thereafter being able to read the results, being able to understand signs, the results that you see, there are signs. They are telling you something which you need to understand. If you can understand that you are in business.

We have taken some things down to very low figures of damping because you realise it's not the absolute damping magnitude of the damping that is important. It is the trend in the damping. You can have damping down to very, very low values. And all that will happen is you'll get a little oscillatory kind of behaviour on the aircraft, but nothing else. It's not unsafe at all. It's just a little weaving, the kind of motions you might encounter or not at all. You may not even feel it, but there's no danger. Whereas you may see damping rising very rapidly. And actually, that is telling you that if you push any harder, it's just going to explode on you. Literally. It's called explosive flutter. So that's the whole thing about flutter.

Now, flight testing it, therefore, like I said, you have to put her in those test conditions in a very controlled, calibrated manner, which is pretty easy. It's a trivial activity when you are talking about speeds and heights which are within the level flight capability of the aircraft. You just take the aircraft to that height and speed and accelerate to that speed and throttle back and hold, nothing to it. And then they run this software routine which moves the surfaces and you feel a little bit of a vibration on the aircraft, but you don't really see anything. And then they get the data. They look at it and they tell you it's okay to go to the next one. It's pretty boring, actually. It's very anti-climatic kind of testing. It's boring work.

The thing changes completely when you now get to parts of the envelope where the aircraft cannot reach with its own thrust. So let's say the aircraft is capable of 600 knots at level flight. She's capable of accelerating, the thrust is sufficient to take the aircraft up to 600 Knots. But I want a speed envelope of 700 knots. Now, how do I take the equivalent of 700 knots? The only way is to put her into a dive. You can ask the question, Why do I want to take her to 700 knots? Because if an aircraft can achieve 600 knots, let's say at sea level, in level flight, if I dive her from 10,000ft, she will have reached 700 knots by the time I reach sea level. The frontline pilots are going to take the aircraft to those kinds of speeds.

Now, how do you test it? It's not just a matter of putting her into a dive. There was this old poem, “Put her into a dive and see if she holds, and if she doesn't, then I find myself in a ditch.” There was an old test pilot ditty like that. But that is no longer acceptable. In the 50s and 60s, the bulk of the test pilot, that mystique and the whole business of being a Daredevil, et cetera, originated from this thing of the death dive, that you would just take the aircraft up to her height and put the nose down and see if she comes out intact at the end of it.

But that is obviously not an acceptable method in this day and age. So you need to attack it slice by slice. It's not one big mega “put her into a dive, you’re offered a bonus by the company, and if you're alive to collect it, good for you.” It's not that way any longer. So you have to figure out a way in which you are able to, in a calibrated and assured manner, get to a certain heights and speeds combinations while you have to be in a dive to do that. So it's basically a series of very incrementally, steepening, increasing dives, which needs a lot of planning to do in order to get there, because it's not just a matter of, oh, heck, I exceeded the speed that I attended. I intended to reach 620 knots today, but I ended up with 640. No, that's not the point, because your safety lies in that. If I have seen how the aircraft is behaving at 600 knots, then I look at it and say, okay, I think I'm reasonably safe up to 620. By looking at this data, I don't think anything will change dramatically. If I have flown at 600, I think I should be okay up to 620. So the next test has to be at 620, which is within the scope of coverage provided by the previous test point. If I go to 640, I am out in an unknown zone because to get to 640 to say whether 640 is going to be safe or not, you need the 620 data. So you can't have a pilot saying, okay, let's try 620 and I'm sorry it went to 640. You can't have that. Because then you are subjecting the aircraft to just risk. There is just risk with no risk elevation behaviour. So now you're talking about doing this as you are approaching closer and closer to the terminal velocity of the aircraft. So it needs to be done in a very calibrated manner. And the flip of… one can say “just be safe and do it really slowly, how does it matter?” But imagine each one of those supersonic, what we call top right hand corner, that is the high altitude-high mach-high indicated airspeed combinations. The aircraft can basically reach those points once in a sortie. So each attempt or each failed attempt is one full sortie gone, one which can be all the flying that you do in that one day. So each time that you fail, you are finally going to get frustrated and one day just shove the nose down and add another ten degrees extra to the dive and exceed it or you're going to consume so much of flying that your management cannot afford it. So it's a contest between flight test efficiency, flight test safety, and this fact that the science itself is a slightly inexact science. You need to figure out a way in which you can, with some degree of precision and a high degree of control, guarantee that you are going to achieve the test cases that you do. So that's the problem in this negative SEP, negative SEP portion is the part of the aircraft, part of the flight envelope which the aircraft cannot achieve in level flight. It does not have, it does not have the trust to be able to fly in those zones. So we ended up spending a fair amount of brain power and trying to figure this out and a lot of it we've written in that book, Air Marshal

Rajkumar’s book, Tejas, Radiance in Indian Skies. It's kind of described in there. So frankly it might be a better thing if I point people in that.

PR Ganapathy:
Yeah, definitely. I just wanted to understand from the pilot's perspective, what do you experience, what are you trying and I think we've got a sense of that. You're just feeling your way around very incrementally and slowly to that

Cmde Maolankar: [48:21]
You have to have the discipline that comes from analysis. On the basis of the performance analysis. You make a performance plan and then you fly that as accurately as you can. And keeping all your senses open for looking for any signs that are being, that are not being obviously picked up by the sensors. Or, all the data is going to be analysed afterwards. You need to see if anything is going off, anything is going awry while it is happening. So anything you feel uncomfortable with, you have to back out of it, which is basically slow her down, just throttle her back and maybe on some aircraft, it's a good thing to just put a little bit of G onto the aircraft. Steady G, it tends to damp out things. So it's a very disciplined approach to it.

Now imagine you're doing this with refuelling. That means you're doing the full sweep in one sortie. Between each test point, you're doing air to air refuelling, which itself is reasonably stressful, and then you're doing this strategizing about what is the next test point that you want to do. Quite often, the call that you take is that they're not so sure. They're not saying it's unsafe, but they're not so sure how safe the next test point is. So even if you had planned, let's say, a 20 knot jump to the next point, you make a shorter increment, and you say, let's do ten knots only, which means that even your original plan that you had, you may have had a plan for you may have all the parameters written down for the next 20 on jump, but you need to quickly. Iterate something interpolate, something in the middle and figure out a new plan for 610 knots. But that's the way it needs to be done. So you can imagine that all of this is only possible if there is tremendous synergy between the pilots, the flight test team, that is the test engineer, the pilot, and the engineers who have done the design and the analysis. There has to be a complete understanding. For every hour that you spend airborne, you have to have spent tens of days discussing it so that you all have a common understanding of how you want to go about doing the thing.

PR Ganapathy: [51:06]
Move on from there. But before we move on to the next topic that I wanted to talk to you about, which is display flying, I just wanted to quickly speak about the test firing of the Derby missile. I think you were in the chase aircraft, isn't it? The Sukhoi? So can you tell us a little bit about what that experience was like?

Cmde Maolankar:
When we did the first live Derby, I was a safety pilot. I was planning the sortie and kind of monitoring and controlling the sortie. The Derby, I was the most familiar with it because I had done Derby on the Sea Harrier. So I was most familiar with the Derby systems, et cetera. So I had spent a lot of effort in the integration of the Derby onto the LCA also. It was actually a low hanging fruit for the LCA program because Derby we were already familiar with because

of LUSH. Derby had been already specified for LCA Navy by the Navy, because they wanted to have a slightly lighter BVR as compared to, say, Astra. LCA Navy bring-back loads on the carrier, et cetera. So they said, why not Derby? So Derby had been specified for LCA Navy. So ADA was already committed to doing a Derby integration on an LCA, which kind of makes ultimate sense. Why not for the Air Force also. And you'll get a quick, really quick and easy within the same original plan cost, you got a BVR capability for the Air Force aircraft also. So that's how the Derby of the thing came about.

What we needed to do was adapt it properly so that we mounted it correctly. So that was one thing which I spent a lot of effort trying to ensure that we carried it properly on the LCA. The LCA Navy we could do a better job than the LCA Air Force, frankly, but that's a different story. And a lot of the aeromechanical flying that's the opening of the envelope, that I did. The systems portion, by the time that came around, LCA Navy had picked up a lot of headway, so I did not do very much work on the systems part of the Derby.

However, the live firing portion also, since I had done quite a bit… I had done the full separation firings as well as the live firings on the Sea Harrier. So that is another full discipline by itself, weapon testing. And therefore I ended up doing a fair bit of the planning and the execution of the Derby.

PR Ganapathy:
Okay, great. So we'll change gears now to… you did a fair amount of display flying on the Tejas at Aero India, in Bahrain. So just tell us about display flying, particularly with an aircraft that is still in development. What is the objective? What are the issues and preparation that goes into it? What is that experience like? What are some lessons we took away from the demonstrations that we did on the Tejas?

Cmde Maolankar: [54:39]
So this thought process about display flying is something which is actually the first exposure that typically a kid has to flying is somebody doing a display. And unfortunately, many pilots, the last sortie that they do is also an attempted display. So it is something which is an extremely important element of aviation which does not normally get the kind of scientific rigour, literature, structured learning, structured discussion that it merits. It is a full discipline and a science by itself.

Starting with why are you doing the display? So the bulk of the displays that all of us are exposed to in the earlier years when we are growing up certainly was what I call the Diwali Mela display. Every air station will typically have a Diwali Mela. And during that Mela, in order to basically, for the families and for the general civil populace, you tended to have, one of the squadrons would be told to do some little bit of displays, and then depending upon the personality of that particular squadron commander or whoever is the display pilot, it would be either very aggressive or it could just be basic speed and noise kind of display or some highly technical… it depended. It was very dependent on the personality of the individuals involved. What is the kind of aircraft that you had and pretty hit and miss in terms of…

For that kind of an audience? As long as there's enough speed and enough noise, it's good enough. The idea is to inspire people to want to become a pilot, although it conveys completely the opposite impression of what you really need as a pilot. You need more discipline and willingness to study as compared to just being dashing and cavalier in your attitude.

That is the typical display which people are exposed to. Now thanks to Aero India, Indians also have got used to seeing Airshow displays and there is a full spectrum in terms of displays that are put up in order to convince a customer. That means controlled or displayed with a very small select audience intending to impress you with a particular aircraft. The aircraft have already gone through selection and already vetting of the parameters and parameter comparison, et cetera. Where does the display fit in all of this? With all of this science and knowledge that is available and all the parameters, why can't you just put them together in a table and side by side compare parameters and be done with it? Now displays are very powerful in terms of conveying a message because they are a message which the full script is in the hands of the person who's choreographing the display. There are no interruptions possible. Even in a presentation, somebody can interrupt you and disrupt the flow of thoughts, ideas that you want to put across in a display that's not so. Display is the ultimate uninterruptible PowerPoint, fully immersive PowerPoint with a phenomenal soundtrack and even a visceral feeling of you can feel vibrations in your body if you stand close enough to the aircraft.

So it is an extremely powerful tool for conveying a message. So what is the kind of message that you want to convey is very important, whether it's just a recruiting message, speed and noise. Fighter pilots are so dashing as a recruiting message, or are you trying to convince the Shah of Iran between F-15 and F-14 fly-off? Very few people know that Iran was offered the F-15 and the F-14 both at the same time. Now normally just off the bat, if you ask somebody which is a superior aircraft, people would say F-15 but it was the F-14 display which convinced them to buy F-14 at that stage, although the F-14 was not superior to the F-15, but it had a more convincing message. So that's the full spectrum of things.

One would ask that, you know, why does HAL or ADA spend so much effort on LCA displays when you have a captive customer? Even for a captive customer, it is very important to do your displays properly. Why? Even if you have a captive customer and even if he is fully embedded into your full development process. Unfortunately, human nature is such that the bulk of the time will be spent on the problems in the program. Even if you're doing a review or if you're discussing all the developmental activities, naturally the activities that are working well, you will skip over or hardly spend any time because they work out exactly as you have planned. It is the problem areas that you're going to spend the maximum number of hours discussing. I'm talking about the customer with the design teams. So there is a natural tendency for a customer who is too deeply embedded or too close to the aircraft to see only the warts. Because you're so close that you're only seeing the warts, you're not seeing the beauty in the aircraft because it's not yet coming to your hand. So you haven't flown the aircraft, you can't fly it yourself. And all you are discussing for week after week is the warts. It's important, even for a captive customer like that, for you to show him in a composite hole that this is what you're getting. Forget those words, just Zoom out and look at the whole aircraft and suddenly it all comes together. This whole thing is worth doing. And therefore, now when you go back and focus on the warts, you are not looking at them as all or nothing, make or break clear this wart, or else I will junk the whole aircraft. You get a much better well rounded perspective of the aircraft. When you see displays, it kind of just slots in together. Dry numbers, even fancy photographs and all don't really have as much power as convincing power as a good display.

So there are displays and there are displays. Now, what were we doing on the LCA? So the first display that we did was so soon after the first flight that frankly, it was a miracle that the aircraft flew in front of the audience, right? So it had a limited envelope and within that limited envelope, they tried to put her through some manoeuvres to basically… everybody was pretty much thrilled that the aircraft was flying in the first place.

That kind of held us through a little bit till the first few Aero Indias, when it shifted to the first few Aero Indias, which LCA participated in. It was good enough. But then you could see that in comparison to the other fighters that were being flown, and you could then begin to see the fact that how this aircraft has not grown or expanded its envelope like it should. So it basically drives you into an area of where you are displaying the capabilities of the aircraft in comparison to other aircraft also displaying their capabilities. It's a capability comparison display. It's a technical display. You can fool the lay public with just generally doing some thrilling manoeuvres or some unique manoeuvres, that unique location, some unique shape, but you are not going to be able to impress the people in the know because they are looking at it as a comparative performance to the next aircraft. The next aircraft after your LCA display is going to be Rafael or before it's going to be a Eurofighter or something like that, and they're going to compare and figure out where does this aircraft fit.

So clearly, you need to develop a display routine which shows off the capabilities of the aircraft. Which is okay, you do need to make it a little thrilling, you do need to make it a little exciting, but that can't be the main substance of the display. That can be in, how it is put together, how it's sequenced, and things like that. It can't be in the main substance. The main manoeuvres that you show have to be designed to showcase it. The ultimate way in how not to showcase an aircraft is to crash an aircraft in front of a display crowd. So you could show the manoeuvre at 5000ft. It will hardly be impressive, and you could show the manoeuvre too low. And again, it'll be hardly impressive. So you need to show it in a manner where it's safe enough. So what is safe enough that you can complete the manoeuvre? If everything goes well, that is safe only as long as nothing goes wrong. Typically, you are displaying an aircraft which is yet under development, which means there are still failures that are likely to happen, which you can't be too sure about or you can't say for certain will not happen.

In fact, what we found was that the most adverse combinations of flight parameters that we were generating in the flight test program was during these free manoeuvring routines of the air display. When we were doing test cases for Alpha, for example, we were able to generate, let's say, X degrees Alpha, and we were not able to generate more than that. But when you do it at the bottom of a barrel roll and trying to throw into a turn and trying to throw in a very rapid roll rate, we found that we would achieve X plus two. So it is important to understand that you can't say that I will have everything under control. At the same time, it was important to use this free form manoeuvring as part of filling out the envelope. One is to stake out and do all the test points at the periphery of the envelope. But in between, which is the combinations. These envelope diagrams are typically single parameter diagrams, height versus speed or something like that. So combinations, what about side slip? What about angle of attack? What about roll rate? What about pitch rate? What about G? Those combinations you can only kind of create when you do a little more free form manoeuvring. It's like colouring in drawing the outline and then colouring in block, filling it with a pencil in the middle.

So you need to look at air displays with all of this in mind. So we got away with some of the initial ones by just putting together a routine of some standard manoeuvres. Then we found that the roadblock was skill level. That means how much time are you able to dedicate just to display flying? Typically, in a developmental program, you don't get the amount of effort and time to guarantee good, safe display because it costs effort to give you that flying just for display practice purposes, as opposed to, let's say, a company with a fully developed aircraft which is now developing a routine just to entice customers, they will be willing to put aside a full month each time with 25 sorties, build up syllabus. Whereas an agency like ours, which is also trying to concurrently do the real development of the aircraft, may not be able to afford that. So you have to ensure that it does not exceed your skill levels. And by that, what do I mean? I mean you should not have to play it by ear through the manoeuvre. So, for example, if you do horizontal maneuvers, it's fine. Because even if the manoeuvre turns out to be different from what was originally planned, it's fine. The trajectory is safe. It's horizontal. If you start going oblique, oblique, downwards, there is still enough escape room in the sense the trajectory is not so adversely downwards that you can afford to shallow it out and not hit the ground fairly easily. But to commit yourself to a fully vertically down trajectory, you have to have done enough planning. Enough what-ifs. You have to have all your go, no-go parameters clearly mapped out. It requires a fair bit of planning effort to go into it. So you can't commit yourself to steep, vertical manoeuvres, particularly downward trajectory manoeuvres. You can't do it on the basis of skill. You have to do it on the basis of effort. Planning effort.

So we found that we were not willing to commit to these deep, steep vertical manoeuvres because of the amount of effort that we had put in or were able to spare. And anything more than what we were doing would start becoming a skill based activity, which is not the way it's supposed to be. Second is, some of the limitations of the aircraft or the rough edges. The unfinished work on flight controls was beginning to be apparent. When you're trying to show the rapid roll rate, the way in which the roll rate was being arrested, or even the roll rate itself that we were generating. You could see that the aircraft needed some more work. Just by standing outside as a spectator. You could see that the aircraft needed a little more work. You could see that some of the manoeuvres were not tight enough because the G envelope of the aircraft was still restricted. So basically, we were running up against the limitations of the envelope of the aircraft. The envelope had yet to be open to its full envelope. And lastly, was the fact that you were not showcasing it in manoeuvres that you could directly, and without measurement, which measurement it would give direct information to the spectator that whatever you're reading in the press is not necessarily the whole truth. Turn rate is low. You can see in front of you. You can see how long it takes to turn through 360 degrees. If you just bother to sit with the stopwatch, you can see it in front of you. And then you can see for yourself whether the aircraft is really as bad as it's made out to be in the press.

Don't forget, this is the period when all articles about anything to do with aviation in the newspapers used to start... whether it was literally any story about anything he completely disconnected to the LCA would start with “Because LCA is delayed and because LCA does not meet the requirements…”. Therefore, something else would start. That was the lazy kind of storytelling which was happening in the lay press.

It's very important that you don't let this kind of stuff get away with it, because that is also affecting the kind of talent which your program can attract. So I'm building up this picture of how important are these displays. And it's a full spectrum activity. It's not… like I used to keep fighting inside the system... It's not a *bandar nautch* [monkey dance]. In the old days, a guy would come around on a cycle with two monkeys and with that *damru* and they would do some gymnastics and that's it. It's not that. That's not what an air display thing is all about. It's all about convincing people about whatever message that you want to convey. So when will the LCA get exported? When prospective customers think of you, when they are cooking up their RFP, they bother to send out an RFP to India because they have it in their head that India also makes aeroplanes. That is not going to happen until you are regularly seen at the air displays, you are regularly seen on the airshow circuit. Your products are regularly seen in the right context. They are seen flying there. So how do the Malaysians or Bahrainis see your aircraft unless they get to see these kind of things. So it is something. It's a slow burn. It's like wetting the ground. You need to pour enough water to make sure that the ground is then fertile. And that is when… I'm saying this, because when we went to Bahrain, a lot of people ask me this question, but why are you wasting your time? Because you're never going to be able to sell an aircraft in the desert. So you say no. This is all part of a complete spectrum of activities that need to be done. How to sell an aircraft, whom to sell an aircraft. Like I said, even your captive customer needs to be sold the aircraft.

So you need to put together a display for this purpose. So like I said in the Aero India routines, we were beginning to run up against skill. We were beginning to run up against manoeuvres that we could not do because we did not have enough effort to plan the manoeuvres or scientific rigour to plan the manoeuvres. We were running up against the envelope limitations of the aircraft. So when this Bahrain thing came around, it was a good excuse to just break out of all this and do a fresh thing.

PR Ganapathy: [1:14:22]
What is fascinating is that your 6-G to 8-G limits software upgrade came just in time.

Cmde Maolankar:
It came because of the display. Not just in time. It came because of the display. So pressure was because of the display. So when you put it together like this, then you come up with a plan and you realise that, okay, how do I go about pushing it. Even to convince the management, for example, that this effort that I'm asking for is worth it. Now, one of the ways I figured was that if you sold it to them as a way of expanding the envelope or using it as the thin edge of the wedge to force the issue and finish off the envelope. There were some parts

of the envelope which were waiting to be opened up. But we were just never really getting around to it because they were not deemed higher priority items at that stage. Flying effort was being expended on other aspects of the envelope. But it was lying there untested.

And we have developed a firm belief that all these basic things you must test out as early as possible. Because let's say when you open up the envelope, if something breaks or something is not deemed strong enough, now undoing that or modifying the aircraft for that is going to take a long time. So these are not things that you should do as the last of the program just before delivery of the aircraft to the customer cannot be the edge-of-the-envelope test point. It can't be. That is just simply too much risk to take. Because everything that turns out to be not as planned. You're looking at a straight delay. There's no chance of making up that time. So you have to do these things in fact, as early as possible. Because every time you actually flight test it, is where you will invariably have some surprise. Invariably, without fail. Whether you're a developed country, whether you're a developing country, it doesn't really matter. F-35C had to do arrested landings in order to realise that his hook was too short. This is coming from a country which had probably 100 carrier aircraft. So it's not a criticism, it's just simply a matter of fact.

It's in fact, one of the philosophical differences between a flight test centre and a development agency. We are trained to be professional cynics. Everything looks good, but let's see if it is as good as it's supposed to be and as early as possible. Making, if necessary, all kinds of deviations and compromises in order to get as quick a look as possible. Which is pretty much what, for example, the 8G for Bahrain. We wanted that 8G. We wanted to push that 8G into the aircraft envelope. So even though those prototypes were those LSPs were of a slightly different structural standard as compared to the aircraft that were going to be delivered to the series production aircraft. And therefore, we would have had to accept a slightly restricted speed band within which that G was permitted. We accepted it. We took it because it made sense. Let's just do it. And in doing so, even the limitation that that person is putting is his understanding of what's happening on the aircraft. So let's push it.

And in fact, we rehearsed on a 6G aircraft until just before we flew to Bahrain. We had worked up initially here in Bangalore. Then we did a small, like a training camp, sports training camp at sea level in Jamnagar, because the performance of the aircraft would improve as you went down from 3000ft to sea level. So to adjust to what are the expected conditions in Bahrain? And that is also when this 8G software on the thing actually landed up. I'm talking about the 8G software for the display. 8G by itself we had flown on. We just opened up the envelope, opened up the limiters a little bit on the existing software and flown it here, as a means to test the structural aspect of it. But embedded within the flight control that is permitting 8G arrived just before we figured out. And so we did a few quick rehearsals. But because we had designed the display in such a way that the 8G was only used horizontally, so it did not change our display so substantially that we had to redo the rehearsal. And so all the vertical part of it was within the pre existing capability of the aircraft, we structured it that way. Now, therefore, what is it really that you are trying to show in that display routine was we wanted to address specifically all the criticisms of the LCA that had been spoken about everybody on Bharat Rakshak, and Twitter. Everybody has an opinion about the LCA and what are the specific things that everybody was talking about. One of the things was underpowered. Okay. So we said, okay, let's put it in context. Let's show them what power the LCA has. And that means let's do out and out manoeuvres which are completely a function of how much power the aircraft has and let people see for themselves whether, yes, it may not have the same thrust weights and power as a Eurofighter or Rafale, but does it have enough for you to be in the same ballpark and therefore tactics and skill come into play? Or are you so simply outclassed that any amount of training and tactics and weapon work is not going to give you a chance? So many of the manoeuvres were designed to show that.

The second was this expanded manoeuvre capability of the account. We wanted to put out the expanded manoeuvre capability. So we said, let's show them sustained turns and instantaneous turns. That means what is the Max turn rate that the aircraft can generate, as well as what are the Max sustained rates that she can generate. So let's do full 360s oriented also in a manner so that a person can stand with the stopwatch and get a first cut feel for himself. Whether it is ten degrees per second or it is 18 degrees per second, what is it? So you get a direct first hand feel for many of these parameters.

And the confidence that we would be able to impress at the end of it was coming from the fact that we had finally expanded and pushed out the envelope of the aircraft to what it was supposed to be capable of. Then you just need to add a little bit of drama to the whole thing. So, for example, negative G. No, negative G is an ugly manoeuvre inside the cockpit itself. If you show it in the classic thing, which is upright and pushing downwards, it doesn't really convey too much of a message. But when you show it in some kind of a weird manoeuvre like an outside turn, the aircraft visually appears to suggest that it should be turning one way, but actually appears to be moving the other way. It just puts it together. It is a little bit of artistically packaged to be very interesting.

It is also interesting that that was the way in which we were finally able to expand the negative G envelope of the aircraft to the negative G limit. We were otherwise not being able to achieve the maximum negative G. And here finally, during the Airshow routines, in fact, we were exceeding what we were planning to restrict ourselves to.

So you add a few elements of this drama into it, and then once you are ready with all of this, then you need to do a little bit of showmanship, a little bit of professionalism in terms of packaging them so that you're not spending... typically, an Airshow routine has got to be done in a small box in front of a crowd. Now, these high speed fighters can't stay permanently inside that box. They need to keep exiting the box and then turn around 180 degrees and come back again through the box and do a manoeuvre, and then again exit the box to the other side and then again turn around. So if you look at it, one third of the time that you get only is spent in that box doing the manoeuvres of interest. And one third is spent turning around at one end and one third is spent. The last one third is spent turning around the other end. So two thirds of your time is spent just in turning around the aircraft, which can get pretty boring. So you need to package them. You need to change the axis in such a way that even your repositioning manoeuvre are adding to the aesthetics of the display. You need to change the lines. You can't just work on a linear. You need to work in a V. As you get further from the crowd, you need to go up higher so that with the same posture of the audience, they are able to view the thing you're setting up, you got to put it on a stage for them. So that becomes the next layer. And of course, then there is this layer of safety, which actually has to come out right at the beginning. Because when you're planning your manoeuvres, that you have to be able to handle one failure, definitely. You definitely have to be able to handle any single failure and guarantee that, A, you're not going to hit the crowd and B, that you can recover the aircraft out of that and botch your display and recover. But the bare minimum is that you should not plough it to the crowd like has been seen on so many displays. So now that is something which is just pure hard work, figuring out what all can go wrong, tons and hours and hours of simulator work. So a lot of the manoeuvres which we wanted to do, for example, but we could do them only if the aircraft was fully serviceable. You couldn't guarantee that you can tolerate a single failure. So then you obviously have to drop for those kind of manoeuvres. Some manoeuvres where there is a strong potential of exceeding your envelope, you need to set aside, because again, it becomes a skill dependent activity. So this is how the whole thing came together. And it was actually many months of work directly on this profile.

But like I've described to you, it is many years of thinking about displays, starting from even the designated display pilot of the Sea Harrier. Even there, for example, I learned that the Sea Harrier displays because they are largely dependent on V-STOL, which means wind dependent. You couldn't ignore the wind. So, for example, the Sea Harrier display had to be mix and match. You could not have a fixed, rigid display routine of a sequence in the sense like today the winds are down the runway and tomorrow the winds are completely crossed by 90 degrees. You cannot insist on doing exactly the same manoeuvre because you will get into deep trouble. So there are enough times when either you need to choose a different manoeuvre or sequence the manoeuvre differently, do it in the opposite direction, or some such thing, which is complete anathema to the way militaries control display flying. It's a very heavily, extensively documented profile. It's like literally like a series of hoops that you need to go through. It's a proper gymnastic routine, and it goes up many levels of the command chain. Any deviation from it, you're going to get it in the neck. But the moment they designated me Harrier display pilot, I had to first convince them that you will drive me to the ground. If you do it that way, you have to give me this flexibility. I will list out the manoeuvres and list out the conditions. And on that day, I will have to do mix and match.

Whereas here, so for example, in Bahrain, we had to cope with a scenario where, unlike most display menus, the crowd was at one end of the runway, not in the middle of the runway. So naturally, the thing was, what you do after you take off, normally you try and show as short a take off, as quickly as possible, get off the ground. But if you did that, you would be so far away from the crowd that it didn't make sense. The other option was to line up halfway down the runway and where those old adages come out, “runway behind, sky above, fuel left in the Bowser, no use to man or beast.” So it would be foolish to get into trouble where having lined up with 5000ft runway behind you. So you say, okay then in that case, we'll get her more and stay low and do a high energy manoeuvre in front of the crowd. So that's how that business of staying low and then doing manoeuvre came in rather than as short as possible a take off. Now you can't take that and do that in a different venue where the crowd, let's say, is at the centre of the runway because you're starting from one end, you're taking off and then going to the other end, far away and out of sight. Doing the same manoeuvre doesn't make sense. You have to adapt the routine to each one of these locations.

So with all of this, you will have seen that the people who need to display the aircraft have to be the OEM's test pilots, because they're the only guys who can create this and do this flexibly enough and still show you they have the resources to throw at scientifically creating a safe and interesting and display that puts across the message. I am a firm believer that OEMs should display aircraft and not… certainly when it comes to where you're trying to show your aeronautic prowess or you're trying to sell a product, it should not be service pilots because service pilots are not equipped and they're not trained to think in this manner.

PR Ganapathy:
So you've flown also with some of these visiting Chiefs and things like that. What are those routines like? What is the purpose of some of those sorties?

Cmde Maolankar: [1:30:50;
Again, you need to do a little bit of homework as to what is the kind of person coming to you. Is he already a fighter pilot? What kind of aircraft has he flown? What is the idea with which he's coming to see you? What are you trying to impress him? So when you fly a USAF chief or you fly a Sri Lankan Air Force Chief or a Turkmenistan Air Force Chief, you can't approach it the same way because you might be hoping to sell it to one of the countries, another country, you're just trying to impress them about how far you've gone down your development. I mean, they're completely different messages for different kinds of people. So again, if he's a non-pilot, for example, you naturally have to keep it to a low… the kinematics have to be calm. You can't have a very dynamic display, and have him getting airsick at the same time.

If you know that he's out and out true blue fighter pilot, you are going to have to give him controls. You cannot stick him in the backseat and say, I'll show you. There is a fair bit of planning that needs to go into how do you target a particular person of interest whom you want to put a message across to, whether it's a Press reporter, is it an aerial photographer, is it an air chief, is it a Minister? What is the message that you're trying to put across?

Now, some of the things that we have kind of figured out is some of the strengths of the aircraft we must try and show. Certainly when you're looking at somebody who could, if not right now, then in future be a potential customer, then what you cannot show from outside in an air display, obviously, the real manoeuvre capability, the aircraft you can only show in a display format because even if you give him controls in the air, first of all, it's a two seater, not a single seater. So two seater performance is not the same as the single seater performance. The second is you can't let him do the same manoeuvres that you can let the display pilot do in front of him. So then you have to look at these sort of as an adjunct to that thing. That is, what is it that I cannot show in the display? So, for example, I can't show you how well my displays have been designed, my multifunction display formats have been designed. How well have the sensors been put together? Can I work with three sensors at a time and therefore handle targets which are deeply camouflaged, things like that? Those are the kinds of things that you put together. So very often you might even choose to weigh down the aircraft with drop tanks, with an LDP, with maybe even a practice weapon, for that matter.

You would actually deliberately load it up and you're sacrificing performance with the purpose of showing him specific capabilities. So you'll see that each one of these things actually, when it comes to when are we going to sell an aircraft to another country? It's really going to be when we learn this full spectrum and internalise the full spectrum of activities that need to be done, including our publicity material, for example. Now this is slightly politically incorrect thing to say, but it just shows you that you have to think from a different perspective. Now, since we have been struggling so hard to convince our own country that it is worth spending this much of time and effort on making these platforms, and you're always fighting criticism of the programs, et cetera and all. So if you see a lot of our publicity material has a multiplicity of agencies. It takes great pride in showcasing the number of agencies who have contributed towards making this platform. Whereas if you see Boeing or Dassault, you don't get to know who their sub-vendors are, right? You don't get to know or who are the agencies that contributed to them. So what is the difference now for a real customer? If you're showing an audience and you're trying to fight criticism of the program, this kind of publicity material is great with a whole lot of mug shots of a whole lot of agencies. But if you are talking to a serious customer, he's going to get frightened by the fact that whom do I deal with? Because a customer typically want a single point of contact and a single point of responsibility, he doesn't want to be bounced around between all your various downstream agencies. So this thing is, I think, the next big area in which we need to put some really talented individuals get a concept going which runs across year by year, not just kind of everybody reinventing the wheel or just doing the same thing, repeating the same thing moving forward. These are all things that we're going to have to do if we truly hope to sell aircraft and it's only when we truly hope to sell aircraft will we have the money to actually invest in really high end work.

Participant #1:
Well, folks, that's all we have time for today. However, my conversation with competition carried on. We did almost 2 hours and 45 minutes in total, so stay tuned next week for the second half of this conversation.