Chapter 6. Camshaft and valve gear selection

Selection of the camshaft is the first step in building a modified engine and it needs to be based on several factors.

i.e.

- Intended use for the car and engine e.g. Road use, track days, race use.
- Type of car e.g. from light open wheel racer to heavy Lotus Cortina.
- Desired power band and torque characteristics and related bottom end and head modifications intended, and if it's desired to run the engine above 7000 rpm.

Many camshaft suppliers provide a list of potential cams for modified Twincams but very limited information on which cam to select and why. Below are charts from two well-known and very reputable UK suppliers of cams that illustrate this, I picked Newman and Kent to show as they are suppliers I would trust and even so, their data is not that useful in cam selection. I could have picked other with even worse information. The web sites or catalogues usually also have additional general information on camshaft selection but if you don't know what you're looking for it still leaves you in the dark. Also, any of the data presented needs to be very carefully interpreted as the details of how it is measured can significantly affect the outcome and this is usually not quoted and often the data tables also have mistakes.

Newman Cams

Lotus Ford Twin Cam Camshaft Data :- Twin Cam 8 Valve

Part No	Application	Power	Duration		Valve Lift		Cam Lift		Timing		Full Lift		Lift @ TDC with clearance		Valve Clear		Price	Material
		Band	In	Ex	In	Ex	In	Ex	In Open	Ex Close	IN. ATDC	EX BTDC	In	Ex	In	Ex	Ex VAT	Type
LOT/270/352 PH1	Fast Road Cam	1500 6000	270	270	0.352 8.93	0.350 8.88	0.352 8.93	0.350 8.88	25-65	65-25	110	110	0.047" 1.2mm	0.047" 1.2mm	0.008 0.203	0.010 0.254	£450.00 Per pair	Blank
Notes	The Original Lotus Special Equipment Cam Profile Superb for Normal Road Use																	
LOT/280/382 PH2	Fast Road Cam	2000 6500	280	280	0.382 9.70	0.382 9.70	0.382 9.70	0.382 9.70	30-70	70-30	110	110	0.080" 2.03mm	0.080" 2.03mm	0.008 0.203	0.010 0.254	£450.00 Per pair	Blank
Notes	Cam Suited for Fast Road Rally Use. Should Fit without Cutting the Spring Seats But Check Fitted Spring Length																	
LOT/280/420 PH4	Tarmac Rally/Sprint Cam	3750 7000	280	280	0.420 10.66	0.420 10.66	0.420 10.66	0.420 10.66	32-68	68-32	108	108	0.088" 2.23mm	0.088" 2.23mm	0.008 0.203	0.010 0.254	£450.00 Per pair	Blank
Notes	High Torque Rally Camshaft Springs Seats will Need Machining																	
LOT/280/443 PH5	Race Cam	3750 7000	280	280	0.443 11.24	0.443 11.24	0.443 11.24	0.443 11.24	32-68	68-32	108	108	0.108" 2.74mm	0.108" 2.74mm	0.008 0.203	0.010 0.254	£450.00 Per pair	Blank
Notes	A High Torque Race Camshaft for Non Steel Engines Spring Seats will Need Machining																	
LOT/306/408 PH4	Tarmac Rally/Sprint Cam	3750 7000	306	306	0.408 10.36	0.408 10.36	0.400 10.15	0.400 10.15	47-79	81-45	106	108	0.130" 3.3mm	0.118" 3.0mm	0.008 0.203	0.010 0.254	£450.00 Per pair	Blank
Notes	The Original L1 Race Camshaft. Spring Seats will Need Machining. Ideal for Endurance Racing																	
LOT/320/450 PH5	Race Cam	3750 7000	320	320	0.452 11.47	0.450 11.42	0.452 11.47	0.450 11.42	54-86	84-56	104	106	0.166" 4.21mm	0.146" 3.71mm	0.008 0.203	0.010 0.254	£450.00 Per pair	Blank
Notes	A Race Cam for Circuit Use Only Based on the Original BRM Phase 4 Profile																	

Newman gives OK information in the summary table, but it needs to be read carefully.

i.e.

Valve lift must be lower than cam lift by the specified cam clearance, unfortunately it is not shown that way for any of the cams.

The use recommendation is expressed as PH1 to PH5 from road to full race. Unfortunately, the LOT/280/443 is shown as a PH5 full race cam when it is not. The power bands for the PH4 and PH5 are not very accurate either e.g. the LOT/320/450 PH5 cam with a 320-degree duration seat to seat cam will have a power band around 5000 to 8500 rpm in my experience.

Newman give some more detailed information on cam materials and matching to followers in the downloadable catalogue (but not on the web site) which is worth reading

Kent Cams

Part No.	Part Type	Description	Manufacturer	Model	Engine
BD3	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
BD4	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
CPL2	Camshaft (Camshaft)	Multiple Applications	Lotus	Twin Cam	1.6
DA1	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
DA10	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
DA12	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
DA2	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
DY1	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
EA1	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
F1	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
L1	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
L14	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
L2	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6
PH4	Camshaft (Camshaft)	Competition	Lotus	Twin Cam	1.6

In the summary table every Kent camshaft is labelled “Competition” except for the CPL 2 which is a copy of the Lotus Sprint cam, and it is labelled “Multiple uses” but all of these cams have radically different characteristics. If you go to the details on each cam, additional information on duration and timing is provided and sometimes some more comments on power band and use but that is not consistently done.

Cam basics

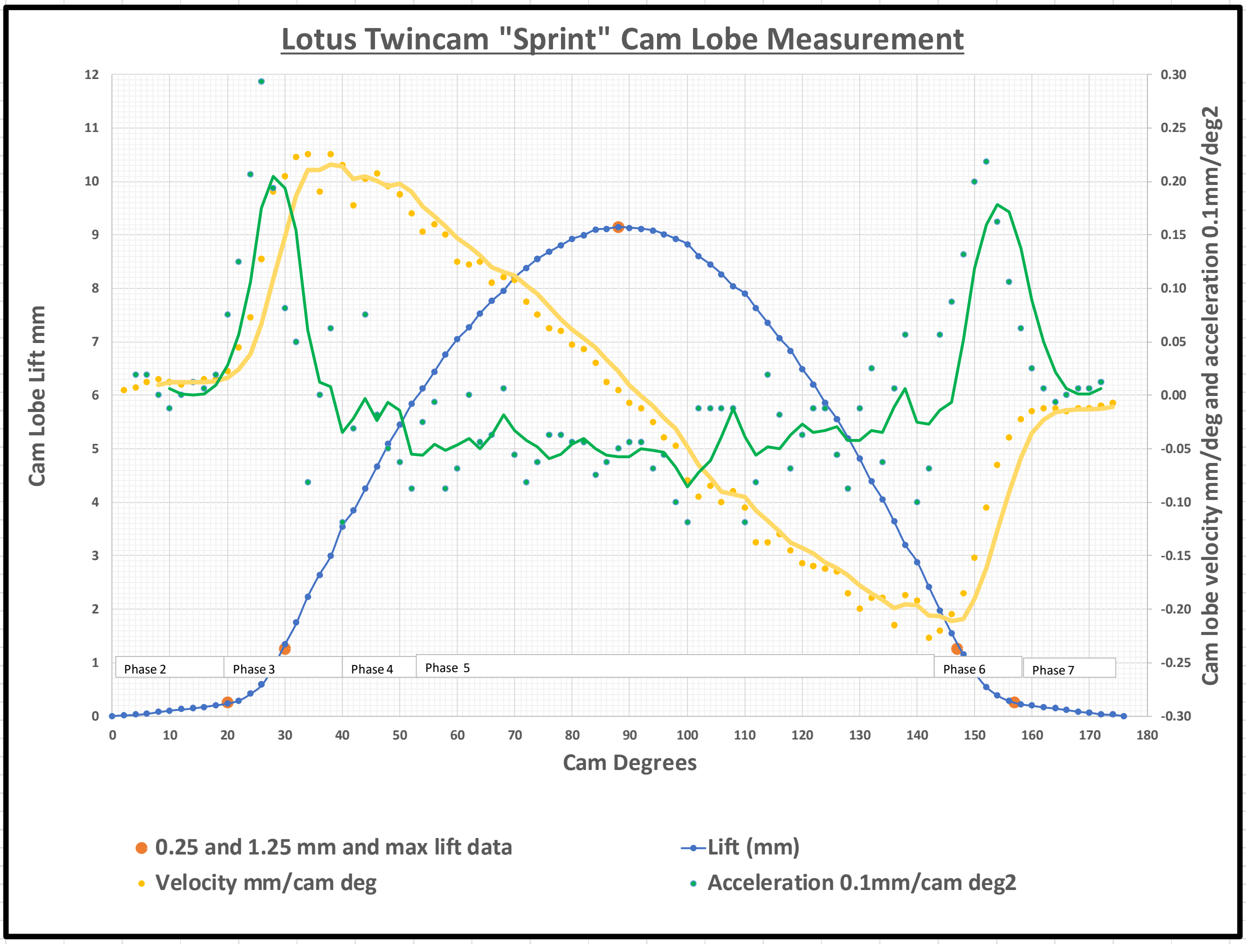
So before selecting a cam it is good to understand the basics of cam design and operation in the Lotus Twincam with its direct acting flat follows and twin overhead cams.

The cam profile can be divided into the following sections:

1. **Base circle.** This covers approximately 180 cam degrees and is the minimum height of the cam lobe. The cam lift or lobe lift quoted is the maximum height of the lobe above this base circle.
2. **Opening take up ramp phase.** This is the initial lift above the base circle at the start of the lobe. This typically lasts for about 20 cam degrees and for about 0.01inch 0.25mm lift above the base circle. This is a constant low velocity increase in lobe lift to take up the clearance in the valve train with minimum shock and noise in the valve train. In the Twincam once the clearance is taken up valve movement lift follows the cam lobe follower as there is no rocker arm with a lift ratio in the system.
3. **Opening acceleration phase.** This is a very rapid acceleration in opening velocity to get the valve off the seat as rapidly as possible. How long and high this acceleration lasts is a key choice of the cam designer based on the loads the cam to follower interface can take and the maximum velocity possible which is dictated by the follower diameter (reference https://www.tildentechnologies.com/Cams/CamDesign.html). Typically, this phase last about 20 cam degrees
4. **Constant opening velocity phase.** This may not be present depending on available time for other phases but if present it is typically short, it lasts about 10 cam degrees in the Sprint cam example below.
5. **Constant closing acceleration phase.** The cam having reached maximum opening velocity now needs to be slowed down to reach zero velocity at maximum opening as it goes over the nose of the cam and then continue closing acceleration to reach to the maximum closing velocity. This closing acceleration is dictated by the valve spring rate and preload and valve train mass and maximum revs the engine is intended to be operated to keep the follower in contact with the cam. This is the longest phase in the lobe and occupies about 90 cam degrees in the case of the Sprint cam below.
6. **Closing deceleration phase.** This is a period of rapid deceleration to reduce the closing velocity to near zero and valve opening to near zero as quickly as possible. Like the opening acceleration phase this is dictated by the interface loads between the cam and follower and lasts about 20 cam degrees
7. **Closing take up ramp phase.** Like the opening take up ramp this lasts for 20 cam degrees and for about 0.01 inch 0.25 mm lift above the base circle. This is a constant low velocity decrease in lobe lift to open the clearance in the valve train at the base circle to minimize shock and noise in the valve train as the valve seats and to ensure the valve is not held slightly open.

The graph below is the measured lobe lift and calculated acceleration and velocity curves for the Lotus Twincam "Sprint" cam in cam degrees. I measured this in the head using the actual follower movement held against the cam by a light spring.

I have marked on the graph the phases of the cam profile described above, the base circle (phase 1) is not shown. Note the scale is cam degrees starting at zero when the lobe starts to lift above the base circle.



Cam Duration and Lift

Most cams suppliers will give you the following data below. It's not always in their marketing information and the details of how its measured are often not available but this is the basic data needed for selection of a modified cam. US cam grinders tend to quote 50 thou lift durations in their marketing materials while UK cam grinders tend to quote seat to seat durations, few quote both, so you need to be careful when comparing cams to ensure you are comparing like to like.

Seat to seat duration (typically in crank degrees). This is typically measured at 0.010 inch / 0.25 mm lift above the base circle which normally coincides with the end of the take up ramps and when the valve leaves and returns to the seat. This is equivalent to phases 3, 4, 5 and 6 in the cam curve above.

50 thou / 1.25mm lift duration (typically in crank degrees). This will be close to the rapid opening acceleration peak and peak of the closing acceleration periods. The difference between the seat to seat and 50 thou duration in degrees gives a measure of how aggressive the cam acceleration is.

Modern performance cams tend to have a more aggressive acceleration to get more lift into a shorter seat to seat duration.

Maximum Lift. This may be quoted in maximum lift above the base circle or lift above the specified valve clearance. Sometimes this data on how it is measured is not given, so you need to be careful when comparing cams.

Cam Selection

As a general statement you want the maximum lift in the shortest possible seat to seat duration when selecting a modified cam. How much duration you can use effectively in an engine and thus how high a lift you can achieve depends on the type of car and use. I will not talk about what power outputs these cams may produce in this section as that depends on many factors in terms of cylinder head modification to improve breathing and bottom end RPM capability, this is discussed further in, Chapter 10 - Summary of modification outcomes.

While I have divided the example cams into 3 categories based on duration and lift the distinction between the top duration end of one category and bottom duration end of the next is small

I have not included any of the many listed close to standard lift but longer duration cams as these are really a waste of time these days due to their poorer torque and power characteristics compared to the cams below if building a modified engine.

Road and track day use in a road car (e.g. Elan or Cortina)

In a road car you need to keep the seat-to-seat duration around 280 to 285 degrees maximum. At this duration you can get the lift between 0.410 to 0.440 inch from various manufacturers. These cams give good low speed torque, great midrange torque and will produce good power at 7000 rpm and above with the right head and bottom end modifications. For reference I have included the various Lotus cams specification.

Examples of these cams are:

Supplier	Number	Seat to Seat duration (crank deg)	0.050 inch lift duration (crank deg)	Timing Inlet / Exhaust (crank deg) BTDC / ABDC / BBDC / ATDC	MOP (crank deg) Inlet / Exhaust	Lobe Lift (inch)
Lotus	Standard (B cam) (note2)	248		15/53/53/15	109/109	0.350
Lotus	S/E (C cam) (note 2)	264	220	22/62/62/22	110/110	0.350
Lotus	Sprint (D cam)	272	232	26/66/66/26	110/110	0.360
Newman	LOT/280/420	280		32/68/68/32	108/108	0.420
Newman	LOT/280/440	280		32/68/68/32	108/108	0.440
Kent	L14	282		35/67/67/35	106/106	0.415
QED	420	285		42/63/69/36	100/106 (see note1)	0.420
McCoy		285	252		107/110 best torque 102/105 best power	0.440
Bean	550E 0114	288	243	36/72/72/36	108/108 (can use 106/106)	0.413

Note 1 - The QED quoted inlet timing in their documentation does not make much sense compared to all other similar cams and maybe is a typo? I would time the same as Kent L14 or McCoy

Note 2 - I have seen different durations quoted for the Lotus B and C cams and this is what I believe is correct, but I have not actually measured either of these Lotus cams to confirm.

More dedicated track use, little road use

For track use you can sacrifice low speed torque for greater mid to upper range torque and greater high-end power to above 8000 rpm and thus push the duration to 300 to 305 degrees maximum and lift up to 0.460 inch. The modified cams in the road use section are also suitable for track use in a car used for road as well as track days, especially the McCoy 0.440 lift cam, where it gives better torque than the longer duration cams and almost the same top end power with good head preparation due to its high lift.

With lighter cars it is possible to push the duration and lift to the top end of this range, doing so on heavier cars may not improve track times due to loss of midrange torque

Combining a shorter duration exhaust cam with a longer inlet cam can improve torque. I personally use the 460 lift McCoy on the inlet and 440 lift McCoy on the exhaust of my Elan

Examples of these cams are: (see Note 2 below)

Supplier	**Number**	**Seat to Seat duration (crank deg)**	**0.050 inch lift duration (crank deg)**	**Timing Inlet / Exhaust (crank deg) BTDC / ABDC / BBDC / ATDC**	**MOP (crank deg) Inlet / Exhaust**	**Lobe Lift (inch)**
QED	Q450	298		Not provided (Note 1)	Not provided	0.440
Bean	556E 0104	300	259	48/72/72/48 44/76/76/44	102 max power 106 max torque (Note 2)	0.440
McCoy		301	266	45/76/76/45	106/106	0.461
Kent	L1 (Cosworth Ll1 copy)	306		47/79/79/47	106/106	0.408
Newman	LOT/306/408 (Cosworth L1 copy)	307		47/79/81/45	106 Inlet 104 Exhaust	0.408

Note 1 – The QED data sheet just provides lift at TDC for installation, but timing should be similar to the Bean 556E 0104 cam

Note 2 – For all these cams timing recommendations are general and may need fine tuning on the dyno for the specific head and carbs and exhaust used and torque band versus max power targets. The Bean recommendations show the type of range to consider and different timing for Inlet and exhaust also should be considered. The Elgin Cams web site referenced in the Appendix gives further information on the effects of different cam event timing

Dedicated track use in a very light car (e.g. Open wheel race car with easily swapped gear ratios)

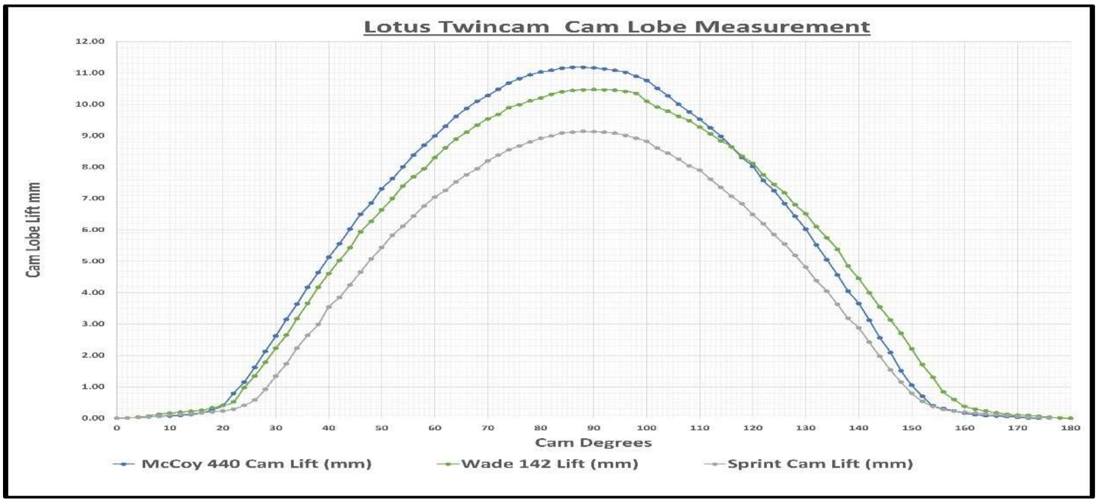
The classic example of this is the original Formula B cars running Hart engines in the 1970's. These cams are all about top end power up to 9000 rpm but will little below 5000 rpm and with seat-to-seat duration of 315 to 330+ degrees and lift, up to 0.500 inch. A very light car with ability to match gear ratios to the track to hold the car in the narrow power band and a high level of driving skill is essential to get the best outcomes from these cams. Probably overkill in historic racing these days even in an old Formula B car unless you are at the very top end in money and skill. Combining a shorter duration exhaust cam with one of these cams on the inlet can help with a broader torque band and improved drivability at the cost of some top end power.

Timing of these cams need to be carefully set based on the general recommendations below as a starting point to both achieve the power / torque band requirements as well as to ensure no clash between the valves or between the valves and pistons due to their long durations and high lifts. Valve location in the head is also critical and Hart with 1.7 inch inlet valves moved the valves back in the head to gain clearance between the valves.

Examples of these cams are:

Supplier	**Number**	**Seat to Seat duration (crank deg)**	**0.050 inch lift duration (crank deg)**	**Timing Inlet / Exhaust (crank deg) BTDC / ABDC / BBDC / ATDC**	**MOP (crank deg) Inlet / Exhaust**	**Lobe Lift (inch)**
Kent	PH4	314		52/82/82/52	105 /105	0.441
Newman	LOT/320/450 (BRM Phase 4 copy)	320		54/86/84/56	104/106	0.450
Bean	576E 0111 (Hart ZL-1 copy)	320	288		102/102	0.476
Bean	576E 0111 (Hart ZL-16 copy)	330	292		102/102	0.497
Kent	PH5	334		60/84/84/60	102 /102	0.438
McCoy		334	285	60/84/84/60	102/102	0.494

The lobe lift profile for 3 different cams shown below. The Wade 142 profile is a Cosworth L1 copy. The glitch in the curves round 100 cam degrees is an artifact of the follower rocking in the bore and can be ignored. The short duration and higher lift in McCoy 0.440 inch lift cam can be seen versus the older cam designs.

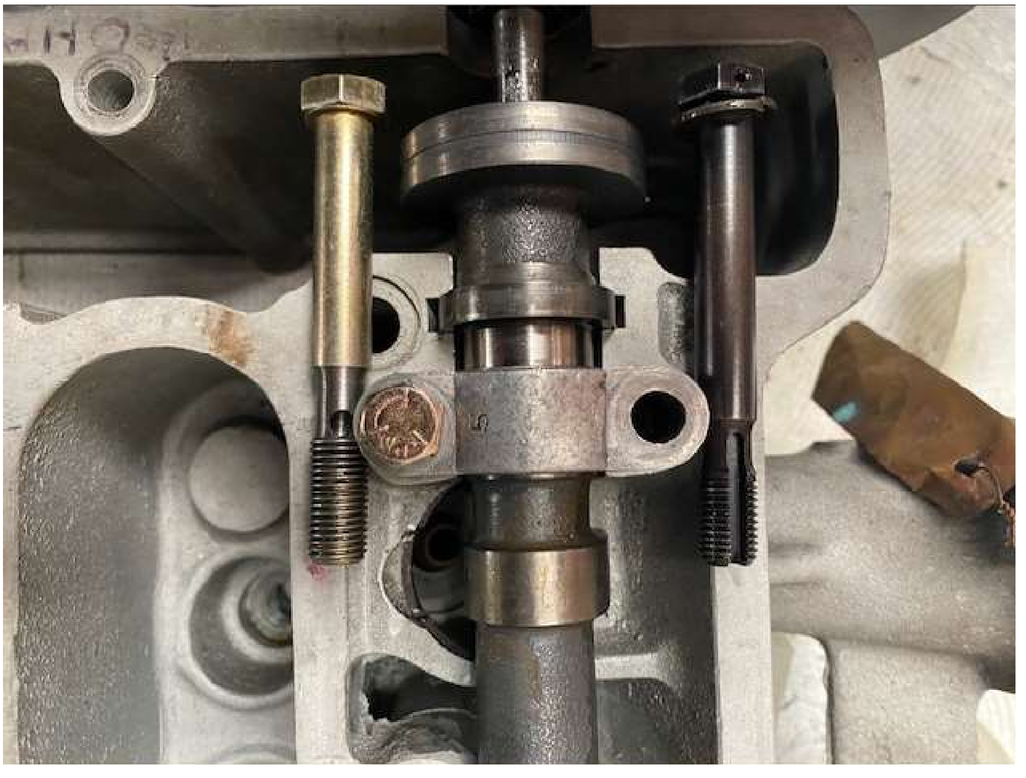


<u>Other Aspects of Cam and Valve train selection</u>

Chilled cast Iron versus nitrided steel cams.

Chilled cast iron cams have the best wear characteristics with flat followers as cast iron is more resistant to galling, where micro welding occurs between the cam and follower sliding surfaces tearing off microscopic bits of metal especially during run in. However, cast iron is not as strong as steel in bending and in a modified Twincam with high lift cams and stronger valve springs it is possible to break the cam at the oil groove in the front cam bearing due to the greater chain loads. It is desirable to install a long sprocket bolt that goes past the first bearing, and which keeps the nose of the cam in compression and prevents it breaking in bending. The Long bolt needs to be modified with an oil passage to carry oil from the front cam bearing down the centre of the cam to feed the other bearings. Some cam suppliers are aware of this need and can tap the cams and supply the modified long bolts, however some suppliers (e.g. QED) do not do this and you may need to do the modification yourself or find a machine shop that can do it.

Examples of two types of long cam sprocket bolts



Steel cams are stronger and do not require the long sprocket bolt modification. However, steel is more prone to galling failures. Thus, its more problematic getting the cam and follower to bed properly on running in and not fail.

Cast Iron followers versus steel followers.

The ideal combination from a wear perspective is cast iron cam with cast iron followers but this is often not possible with modified engines with high lift cams as a thinner steel follower may be required to fit the valve train in. For high RPM engines the lightest possible valve train is also desirable, so a lighter steel follower is used. Cast iron cams and steel followers work OK. Use a good quality assembly lube and use a high ZDDP running in oil and get the followers phosphate or DLC coated for added protection when running in.

If using steel cams and steel followers, then DLC coating is essential. Always use new followers with a new cam.

Cam base circle size

The cam base circle needs to be reduced as the cam lobe size is increased to fit the cam lobe on the follower and clear the head. With higher lift cams you may find the need to increase the size and depth of the standard cut-outs milled in the head and follower sleeve to provide the needed clearance with the cam lobe.

As the cam base circle gets smaller the follower comes more out of the head, so a longer follower is desirable to keep sufficient follower length in the sleeve. Standard followers were 22.1mm long and steel race followers are around 22.9mm that can be purchased.

The original cam base circle was 1.20 inch for the Standard and S/E cam. This was reduced to 1.15 inch for the Sprint cams. A typical 0.420 to 0.440 inch lift cam should have a 1.05 inch base circle and a 0.500 inch lift cam should have a 1.00 inch base circle. Smaller base circles make fitting in the spring pack to handle the larger lift cams possible as well as reducing the lobe nose tip radius from the cam centreline so it fits on the follower and does not hit the head. You may find other base circle sizes on cams especially if they have been re-ground, so you always need to check when building an engine.

Selection of Valves, Springs, Retainers, Shims, and Followers

Once the cam has been selected then the rest of the valve train to match, needs to be selected. There is an almost infinite combination of components that can be nominally fitted in the space available, but the right combination of components must be selected to ensure proper operation. If building an engine designed to run above 7000 rpm then selecting as light components as possible is also desirable.

High lift cams with smaller base circles provide the room to fit a longer valve and spring that can accommodate the required lift. Typical "race length" valves are around 4.00 inch long compared to standard valves of 3.90 inch inlet and 3.85 inch exhaust. They vary between suppliers so check what length supplied before ordering and finalising the valve train design dimensions. Race valves normally come with a reduced shank diameter above the inlet valve head to minimise weight and maximise flow. You can also use a 7mm diameter valve stem versus the standard 5/16 inch to further reduce weight and minimise flow obstruction.

Example of Black nitrided stainless steel race valves from Lotus7.com

Thinner and lighter steel followers can be supplied with varying pad thickness to also enable the longer valve to be fitted with an acceptable shim thickness. E.g. At Lotus7.com they are available with 0.140 / 0.170 / 0.225 inch pads. The standard cast iron followers had 0.220 inch pads.

A large range of suitable spring packs exist from various suppliers. The spreadsheet below shows those that I have measured over the years.

The key selection criteria are installed height for greater than 60 lb seat load and a maximum load on the cam nose of less than 210 lb. You need around 1.5 mm minimum from maximum lift to coil bind. Lower seat load can lead to the valve bouncing of the seat and higher nose load can give problems with cam and follower wear especially on run in.

		Tony Ingram Race and Rally			QED Race Assembly	Dave Bean Special Assembly	Dave Bean Race Assembly	Omnitech IRL Assembly	QED Q55 Assembly	Standard Assembly	Rex Colliver HD Assembly
	Colour	dark blue 2012	Light blue 2020	Red	red	grey	black steel	stainless steel	black steel	black steel	black steel
	Diameter	small	small	small	small	small	large	large	Large	Large	Large
	Retainer	Shim	shim	shim	cap	shim	cap	cap	shim	shim	shim
	Other			Same as QED Race ?	Elan Factory A	Elan Factory B					
	Free Lgth	43.4	42.7	not measured							
Outer spring length mm											
39											
38						44					
37		53	47			54					
36		62	56		42	64		46			
35		71	65		49	73		60			
34		80	74		56	83	40	74	37		
33		89	83		66	93	50	87	42		40
32		98	92	80	76	102	60	98	47		50
31		109	101		87	112	70	110	52		61
30		119	110		97	121	80	121	57	45	72
29		128	120		107	131	89	133	62	54	83
28		137	130		117	140	99	145	67	63	94
27		148	140		127	150	109	157	72	72	104
26		159	150		138	159	119	169	77	81	114
25		170	160		148	169	129	181	82	90	125
24		180	170		158	179	139	193	87	110	138
23		190	180		168	190	149	205	92	120	150
22		200	190		178	200	160	217	97	130	163
21		211	201	185	188	211	171	230	103	140	176
20		223	213		198		182	245	109	155	
19					208		194	260	115	170	
18							206				
17							220				
16											
15											
coil bind mm		19.7	18.5		18.4	20.2	16.2	18.3	17.5	18.0	20.6
								binds on inner			
Notes	Green region acceptable load for seat at > 60 lbs and nose at < 210 and coil bind clearance on nose >1.5mm										
	Red region where coil bind										
	The retainers have different top of spring to valve groove location for the different spring packs so install height may vary for different spring packs for the same valve and head installation										

Modified spring packs come with various style retainers. Titanium retainers are available for lighter overall valve train. They also come with retainers designed for the standard shim or a cap shim that fits over the valve stem. I use those that are designed for standard shims as it is much easier to change the shims to adjust the valve clearances. The cap shims come in limited thickness and must be ground to adjust the clearance when the head is fitted to the engine. People often grind the valve tips to set the clearances with cap shims but the clearance typically moves by a couple of thousandths of an inch when the head is bolted down and this may then require the cap shims to be ground also to finalise the clearances once the head is on the block

Procedure to select valve train components dimensions.

I use a spreadsheet to do the calculations and I have the design dimensions for most of the available components on the market so I can iterate quickly around my selections to find what works for any engine build, but the general order I work in is as follows. Drawing a diagram and calculating the assembled dimensions by hand is possible just slower to examine all the alternatives.

1. Select cam and base circle.
2. Check spring pocket depth from cam centreline to the bottom of spring pocket. This dimension is 2.10 inches in a standard head but Lotus machining was not that consistent and it may vary even across the length of individual heads. You do not need to machine the pocket deeper.
3. Select valve stem length. Normally you would be selecting a 4.0 inch race valve for a modified engine. If using a QED 420 cam and Q55 spring pack this appears to have been designed for a standard length valve but the low Q55 spring loads limits the engine to 6500 rpm maximum.
4. Select spring pack and determine where spring top sits versus valve groove and thus valve top with the retainer provided.
5. Set design valve seat height in the head to suit spring pack seat height and full lift height. Determining what valve seating design height is possible needs careful measurement of the actual head as with new seats and head skimming done over the years there may be limitations on positioning the valve versus the standard original dimensions.
6. Calculate the clearance from valve stem top to the cam base circle and select the follower and shim thickness. The shim ideally is in the 0.080 to 0. 120 inch range and not less than 0.070 inch as an absolute minimum
7. Check the clearance of the bottom of the retainer with the top of the valve guide and the bottom of the follower with the shelf at the bottom of the spring pocket or the lip of the valve spring seat. Also check the clearance of the top of the spring retainer with the inside of the follower, the thinner followers have a very small pad and combined with a thin shim can result in the retainer hitting the bottom of the follower.
8. Iterate the component selection until all the above can be achieved. This process is not easy as it is hard to get full details of the design dimensions for all the components without purchasing and measuring all the alternatives. Even most specialist Twincam builders tend to have a standard formula and use the same components for all modified builds.