Union St Roundabout DfT cycle safety fund

View of Union Street Roundabout from Roff Avenue 2012

The DfT cycle safety fund

- is a grant worth £15 million in total open to local authorities in England (not London)
- its purpose is to improve junctions where there have been a high number of cyclist accidents, or junctions which present major barriers to cyclists.

The deadline for bid submission is **30th November 2012**. Bedford Borough Council submitted an expression of interest (EOI) to the fund on 13th September for the roundabout of **Union Street, Clapham Rd, Tavistock St and Roff Avenue.** If funding is granted, the scheme must be built during the financial year of 2013-4.

Why Union Street roundabout?

- Has the highest **concentration of cyclist accidents** in Bedford Borough between 2004 and 2010.
- Lies **on several important cycle routes** – the "Avenue cycle route" from Park Avenue leading to cycle routes from Brickhill and Putnoe.
- Has been identified as a **major barrier** by cyclists
    - in the 2008 survey of cyclists at Bedford rail station.
    - in the Times national website of problem junctions
    - in A&D plan for Bedford cycle network: No.3: "Improve safety on the Clapham Road / Union Street roundabout".
    - in Jacobs Safety Report "It is recommended that cycle facilities are provided at the roundabout to cater for all movements"
    - in Cycle Network Review for CIL as priority 4 (high priority – major route barrier)
- The major issues for cyclists are
    - relatively fast moving and high volumes of motorised traffic
    - conflicting movements
    - no protected space or clear paths for cyclists
    - uphill gradient from Union Street to Roff Avenue.

Why submit a bid?

It is **not acceptable** to leave Union Street roundabout as it is at present. The junction is **poorly designed and unsafe** for non-motorised users with 5 serious injuries to pedestrians or cyclists over the last 10 years. Congestion is also predicted to worsen at this junction over the next few years. A successful bid will

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- allow safety at this busy junction to be improved at little or no cost to the Council
    - Bid estimate approximately £250-£350,000
- facilitate movement by all modes - cyclists and pedestrians, car, PTW and bus users
- thereby provide people with viable alternative choices to the car for their short journeys
- enable to Council to make improvements which would be impossible without external funding

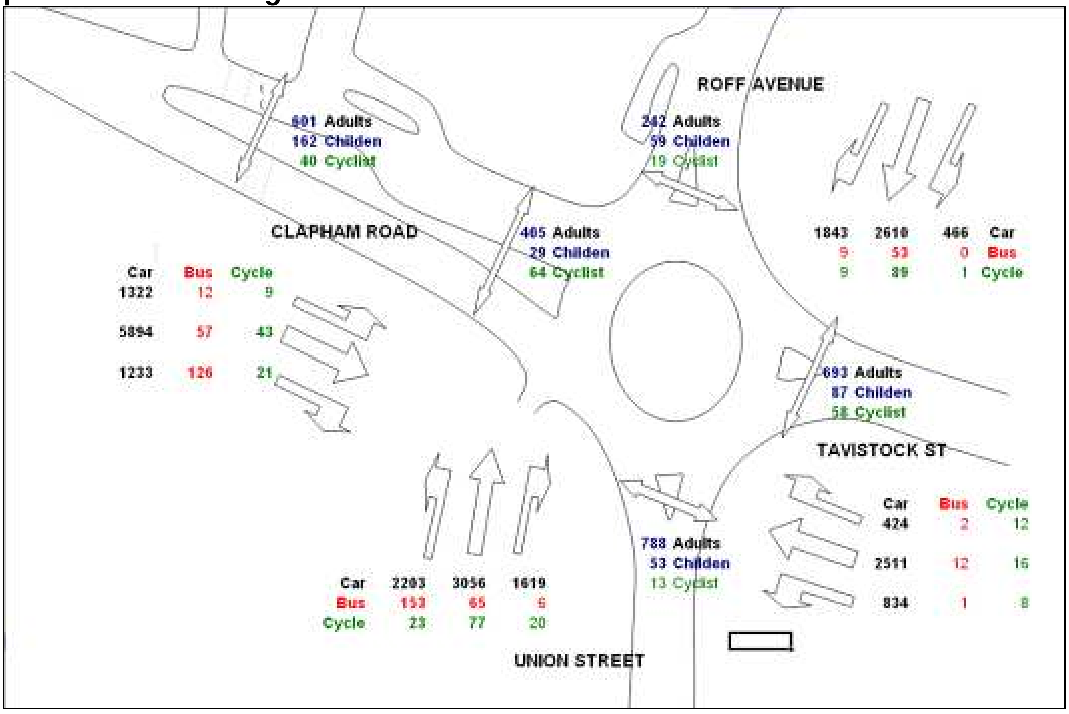
Background data

A traffic survey count was undertaken on 4th October 2012 and showed

- 25,000 vehicles daily (1000 lorries, 500 buses)
    - 2700 AM peak and 2900 PM peak
- 550 pedal cycles daily (2% of total flow) – 350 on-road and 200 off-road
- 3000 pedestrians (including 400 children) cross daily
- 2500 pedestrians cross roundabout arms with no formal crossings

The high numbers of pedestrians crossing on all of the arms is particularly noticeable.

2012 Union Street Roundabout Survey: traffic movements and cycle and pedestrian crossings 07.00-19.00



Union Street and Tavistock Street cycle flows have been counted since 1998.

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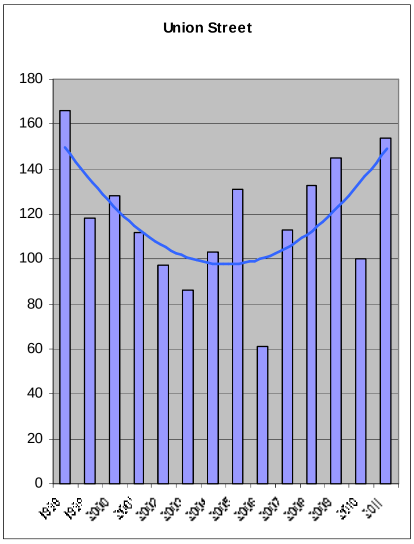
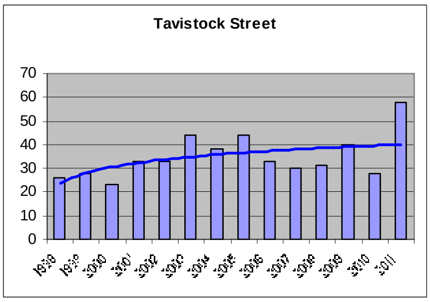




Cycle Flows one day 7am-midday Bedford Inner Cordon Counts
Union Street has some of the highest cycle flows in Bedford. This data suggest that cycling has been increasing along this route since 2003.

What other options were considered?

A range of options were considered and rejected. The final preferred option – “turbo-roundabout” resolves the difficult balance of:-

- **Improving pedestrian and cyclist safety and accessibility**
- **Maintaining vehicular capacity through the roundabout**

Annex A summarises the options that were rejected and why:

1. Do nothing
2. Compact (continental-style) with on road cycling *(as submitted in the EOI)*
3. Compact with off-road cycle paths
4. Unmarked 2 lane circulatory roundabout with annular cycle lanes
5. 2 lane spiral with annular cycle lanes
6. Signalising junction

“Turbo-roundabout” – the preferred option

The turbo roundabout is an innovative arrangement of the two lane roundabout that has revolutionised roundabout design in The Netherlands since 1998. Since 2000 about 160 roundabouts of this type have been built in the Netherlands, 107 outside built-up areas and 44 within built-up areas. Existing multi lane roundabouts will be reconstructed into turbo roundabouts. The main reason is the disappointing performances of multi-lane roundabouts on both capacity and road safety.

The turbo-roundabout meets the 2 main requirements:

- **the traffic capacity of the turbo roundabout is about 25 – 35% higher than a standard two lane roundabout**
- **Dutch data shows that a turbo roundabout is safer than a give way intersection** (±70% reduction in KSI) **and safer than traffic signals** (50% reduction in KSI). As English style roundabouts are more hazardous than signalised junctions, we can expect that **the turbo-roundabout should deliver at least a 70% reduction compared to the existing situation**.

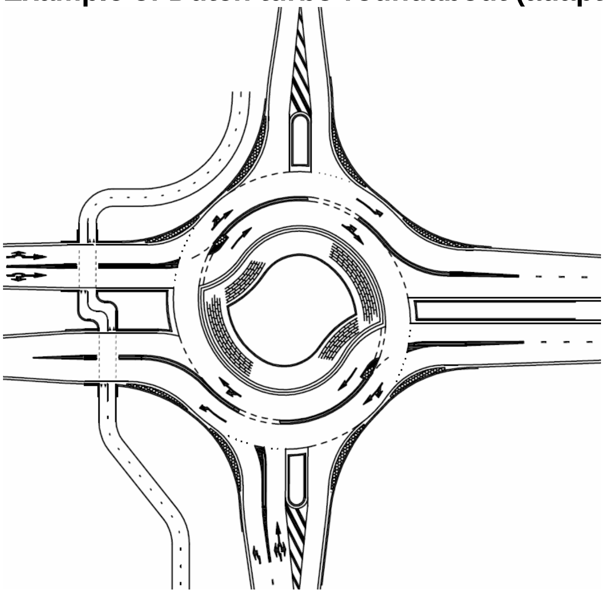
What is a turbo-roundabout?

A turbo-roundabout combines the characteristics of the modern single-lane compact (continental-style) roundabout with tight geometry entries and exits but

- with 2 lane entries on some or all of entries
- 2 lanes of circulation
- Spiral design where lanes are led off at the next junction

- Raised traversable lane dividers to prevent vehicles cutting across lanes

Example of Dutch turbo-roundabout (adapted for UK left hand drive)



Safety

The Turbo-roundabout has the following safety and capacity advantages:

- double lane entries and circulating lanes *(to promote capacity)*
- spiral lane marking on the roundabout to eliminate lane changing while circulating *(to promote safety)*
- no more than two lanes on the roundabout to which the traffic entering from an entry roadway must yield the right-of-way *(to promote safety)*
- geometric design to enforce low speeds (to promote safety).

Speed through roundabouts is the result of the deflection curve radii of entry, circulation and exit. The deflection curve radii on the Union Street roundabout are between 10 and 15 metres, which should result in maximum vehicle speeds under 15mph [See Union St Roundabout Bid Designs for vehicle paths].

Picture gallery of turbo-roundabouts

Aerial View

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Approach to roundabout showing lane signage

Vehicles on circulating carriageway showing lane dividers

HGVs overrunning lane dividers

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Accident analysis 2002-2012

A detailed analysis of accidents at the junction was undertaken to understand whether the proposed improvements options would be likely to result in accident savings (See annex B).

Cost: The 10 year cost of accidents at the junction was £1,823,000 (£1,481,000 serious and £342,000 slight), i.e. £182,000 per annum casualty costs. On the basis of an analysis of accidents and data from similar roundabout accident savings, it is expected that the turbo-roundabout will result in a 75% reduction in serious accidents and a 40% reduction in slight accidents, leading to an accident savings of around £120,000 per annum. **Over 10 years this equates to a cost-benefit ratio of 1:3.**

Mode: Between 2002 and 2012, there were 32 casualties (8 serious) in 27 accidents, injuring 8 pedestrians (3 serious), 7 cyclists (2 serious), 4 PTW users (1 serious) and 13 car drivers/passengers (2 serious). Cars were involved in 25 of the 27 accidents, but in 18 cases none of the car occupants were hurt.

- Pedestrians: 5 (3 serious) were crossing at arms, 2 at or near Pelican and 1 drunk walked off central island.
- Cyclists: 4 (2 serious) involved cyclists circulating roundabout, 1 a cyclist entering the roundabout and 2 at Clarendon St junction
- PTWs: All 4 (1 serious) were at the roundabout, 2 circulating and 2 entering.
- Car drivers/passengers: 3 were circulating/entering whilst 7 involved shunts (1 serious) on approaches.

Location:

- The Union Street arm had the highest concentration of casualties with 11 (4 serious) casualties.
- Clapham Rd arm had 6 casualties (2 serious) whilst the Clarendon St entry and Pelican crossing added 4 more casualties
- Roff Avenue had 4 casualties, 2 involving pedestrians crossing
- Tavistock St arm had 5 casualties (1 serious).

Turbo-roundabout References

Engelsman JC and Uken M (nd) Turbo Roundabouts as an alternative to 2-lane roundabouts

Florin, Nicolae (2010) Turbo-roundabouts, Web-page

Fortuijn LGH (2003) Pedestrian and Bicycle-Friendly Roundabouts; Dilemma of Comfort and Safety. Presented at the Annual Meeting 2003 of the Institute of Transportation Engineers (ITE) in Seattle (USA)

Fortuijn LGH (2011) Roundabouts in the Netherlands: Development and Experiences

Fortuijn LGH & Carton PJ (1997) Turbo Circuits: A Well-Tried Concept In A New Guise

Fortuijn LG (2007) Turbo-Kreisverkehre (Turbo-roundabouts), presentation at "Current themes in road planning" at Bergisch Gladbach.

Tollazi et al. (nd) Turbo-roundabouts – Slovenian Experiences

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Annex A Rejected options

Option 1: Do nothing

The Do nothing option means that the junction will continue to be a hazard for pedestrians and cyclists. The option of putting in Zebras to cater for crossing movements is not possible by itself, because without changes to the junction design, traffic speeds are likely to be too high on their approach. The significant cost saving and potential benefit to pedestrians (and off-road cyclists) of Zebras in terms of improved accessibility and accidents savings in all options is a benefit dependent on a successful bid which also demonstrably benefits cyclists.

Option 2 Compact style with on-road cycling

Compact style roundabouts are common throughout Germany and the Netherlands.

Description and advantages:

- They have a proven safety benefit for all road users, but in particular cyclists and pedestrians, over typical UK roundabout styles.
- Vehicle speeds are reduced to approximately 15mph principally by reducing circulating, entry and exit speeds by more acute deflection curves
- Single lane entries, exits and circulating carriageway ensure good visibility of active travellers for vehicles entering the roundabout – this is the principal type of cyclist accident
- Cyclists take primary position on arms and exits and circulating carriageway, so avoiding conflicting movements

Questions:

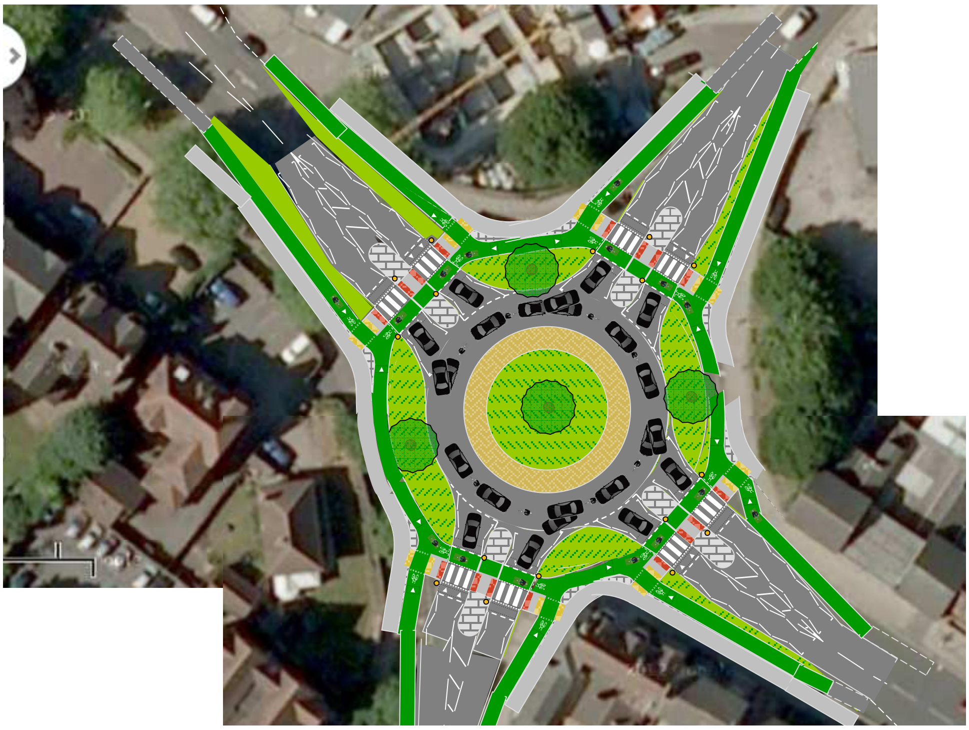
- The generally agreed upper limit of capacity for this junction design is around 25,000 vpd and 2,500 vph, at the limit of recorded daily and peak flows for Union St Roundabout

- Because flows are unbalanced, the paramics model is predicting serious peak time queuing on both Clapham Road and Roff Avenue
- Generally, in Netherlands, this design at this traffic capacity would be designed with off-road cycle tracks (see option 3).
- If peak time queuing does materialise, cyclists and bus users will also suffer delay, minimising their potential benefit to encourage modal change. With the high vehicular flows, a percentage of cyclists will also continue to find this solution too stressful.

Option 2 Conclusion

- Viable safety option but unlikely that traffic capacity issue can be resolved

Option 3 Compact style with off-road cycle paths



This is a variation of option 2, with the compact style but with off-road cycle paths.

Description and advantages:

- For motorised vehicles, as with option 1. At these flows, this is the design that would be most likely to be found in Netherlands.
- For cyclists, there is the option of leaving the carriageway and circulating the roundabout, crossing at the arms. This is likely to appeal to the 200 cyclists who currently use the roundabout by crossing at the arms.

Questions:

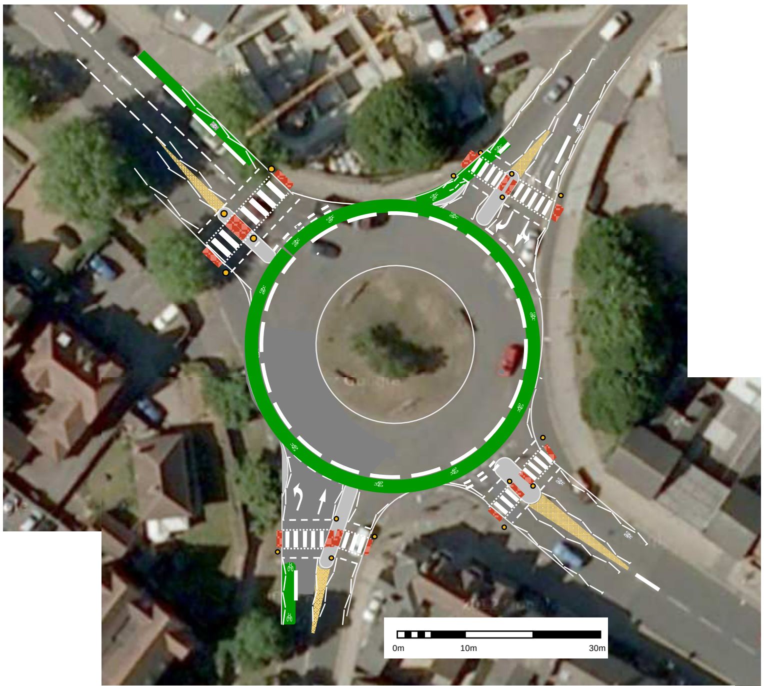
- There are no feasible opportunities to link such a design with off-road tracks on the arms, which are perforce on road because the footways are narrow and heavily used by pedestrians.
- All the cycle lanes leading to this junction are on-road. Most cyclists 350/500 are currently on-road. On-road cycling is likely to be quicker and more convenient for cyclists.
- Additionally, there is no TSRGD design which can give both cyclists and pedestrians priority at crossings on the arms. This means that with this design, cyclists do not have legal priority and the potential of cycle accidents at the Zebra crossings has to be seriously assessed. This design would work better, if the

Zebra/cycle crossings were on raised crossings, but this was deemed impossible because of the impact on general traffic and in particular the high number of buses.

Option 3 Conclusion

- Potential cyclist crossing safety issues and also traffic capacity issues

Option 4 Unmarked 2 lane with annular cycle lane markings



Roff Avenue/Tavistock Street/Clapham Road/Union Street Roundabout
Hybrid compact spiral roundabout with cycle lanes Oct 2012

This design keeps the unmarked circulatory carriageway for motorists with equivalent of 2 lanes and so should meet existing peak time capacity, but adds an annular marked cycle lane for cyclists with a tighter geometry and single lane exits.

Description and advantages:

- Meets current traffic flows according to paramics model
- Provides cyclists with a marked route whatever their origin or destination

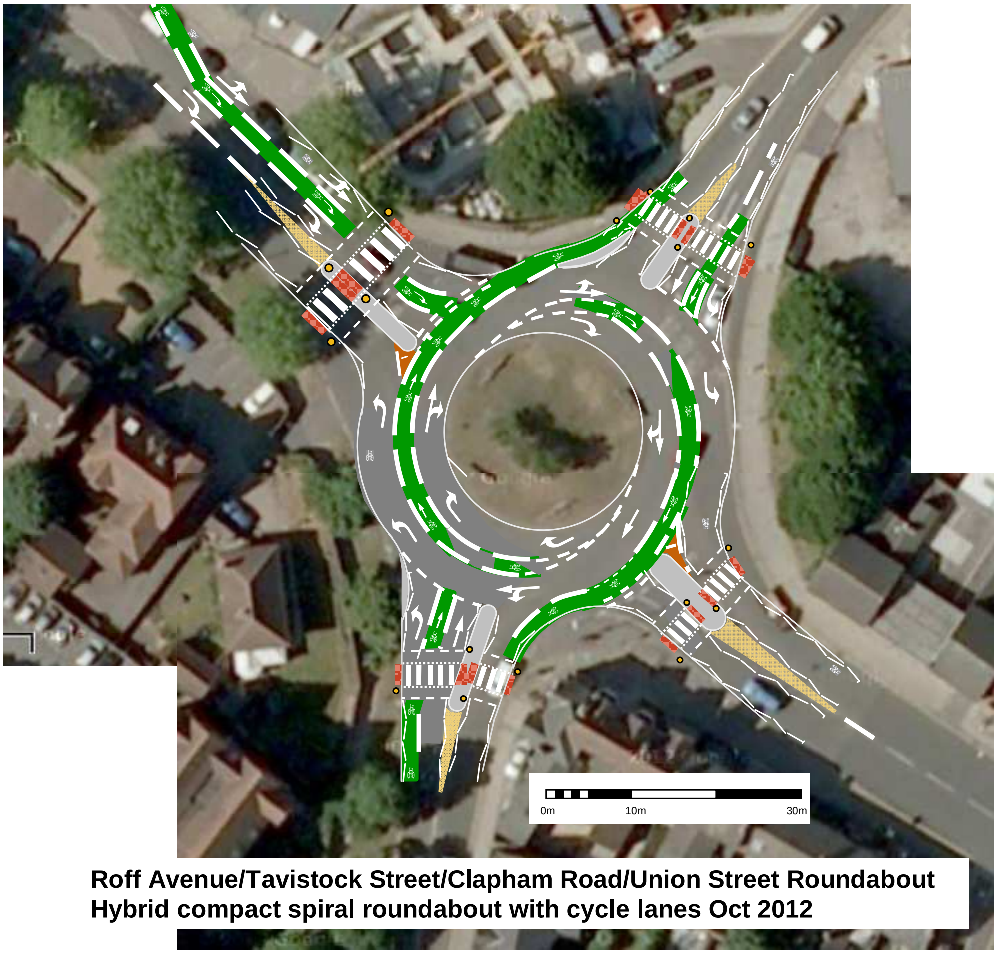
Questions:

- Whilst annular cycle lanes seem simple in design and have been implemented at a small number of roundabouts (the “Magic Roundabout” in York most famously, and less famously in Newbury), the design creates a number of additional conflict points and provides cyclists with a false sense of priority as they cross the various exits. The tighter geometry and single lane exits will counter these conflicts to a certain degree, but the potential for conflicts is still prevalent. It is likely that the design with 2 lanes circulating would potentially lead to an increase in cycle accidents.
- LTN 2/08 states “On busy roundabouts, it is important that the cyclist takes up a prominent position nearer the centre of the carriageway to ensure that drivers understand the intended manoeuvre, and, for this reason, annular lanes are not generally recommended”.

Option 4 Conclusion:

- o Simple design which meets traffic capacity issues, but potential conflict points and false priority, not recommended in DfT guidance.

Option 5 Spiral with annular cycle lane markings



Roff Avenue/Tavistock Street/Clapham Road/Union Street Roundabout
Hybrid compact spiral roundabout with cycle lanes Oct 2012

This design seeks to provide cyclists a clear path through the roundabout via on-road cycle lanes, whilst maintaining greater traffic capacity. A spiral roundabout (without cycle lane markings) has been used successfully at the very high cycling flow “Plain roundabout” in Oxford.

Description and advantages:

- o In this design, cyclists are segregated rather than mix with traffic on most routes, but principally the major cycle flows between Roff Avenue to/from Union Street and the second principal flow from Clapham Road to Union Street.
- o The spiral markings by increasing the deflection curve should have the same effect as the compact style roundabout to reduce vehicle speeds. The radius of curve for the inner circulatory lane is 10m and the outside circulatory lane is 15m. This should lead to vehicles speeds under 15mph. This design reflects the basic design approach of the Dutch “turbo-roundabouts” which have a proven vehicular safety benefit (though cyclists are nearly always off-road in these Dutch designs). Nevertheless, the effect of lower speeds should be a safety benefit.
- o The cycle lane markings reflect cyclist priority, so encourage cyclists to position themselves in the correct positions. Conflict points where cyclists need to move across vehicular flows are limited to the entry arms at relatively safe points (Zebras) or require motorists to cross the cycle lane to get to the left hand turn lane, as is recommended in LTN 2/08

- By linking into cycle lanes on the arms, cyclists will have an advantage over peak time queuing cars, as they will be able to get to the junction in spite of the queues, so encouraging modal transfer
- The design provides priority dedicated lanes for the majority of cyclist movements (220 of 350 on-road). A greater number of cyclists are likely to feel comfortable using the cycle lanes than currently and possibly under option 1. Where cyclists do not follow a marked lane, they will be sharing with slow traffic very much in the way of the compact style roundabout.
- If an inbound cycle lane was implemented along Roff Avenue, there would be a consistency of design for cyclists and motorists on the Avenue Route, as it would lead into the cycle lanes of Union Street and Park Avenue.
- This design has the advantage of reflecting the same approach as the design for Wilmers Corner roundabout, thus creating a greater consistency of design with Bedford roundabouts.

Questions:

- The paramics model predicts peak time queuing on Roff Avenue. Roff Avenue is not part of the strategic motorised vehicle network and it could be argued that the road serves a local population (Putnoe) who could more realistically change mode.
- For a number of movements, cyclists will need to share with traffic as in option 1 – principally Clapham Rd to Tavistock St, Union St to Clapham Rd, and Union St to Tavistock Street. However, the greater deflection should encourage lower speeds which should be safer than the current situation.
- This is an innovative design with no proven track record of safety benefit

Option 5 Conclusion:

- Innovative design, with potential safety advantages and fewer traffic capacity issues, but with some potential traffic capacity issues

Option 6: Signalisation

Pre-requisites for a successful scheme would need to have cycle lanes on all approaches leading to ASL and pedestrian phases on all arms to be comparable to other designs in terms of cycle and pedestrian safety and accessibility.

The design was modelled on the premise of:

- Clapham Road 3 lanes: Left/Straight; Straight and Right
- Roff Avenue 2 lanes: Left/Straight; Right/Straight
- Tavistock St 2 lanes: Left/Straight; Right/Straight
- Union St 2 lanes: Left/Straight; Right/Straight

With 5 light stages:

- Clapham Road & Tavistock Street
- Clapham Road (unopposed right turn)
- Roff Avenue
- Union Street
- A 25 second all-red for pedestrians has been included.

It was found that the junction re-design did not work on 2 measures:

- Insufficient room on the Clapham Road approach to cater for 3 lanes and a cycle lane
- Inability to cope with traffic demand with 5 light stages

Option 6 Conclusion:

- Signalisation was not considered feasible at this roundabout

Annex B: Accident analysis 2002-2012 in detail

All options for the roundabout were tested in terms of the likelihood they would have prevented the specific casualties occurring between 2002 and 2012. The chart below indicates the potential savings over 10 years using DfT figures for the average value of prevention per casualty for fatal £1,638,390, serious £185,220 and slight £14,280. In total there were £1,823,000 casualty costs at this junction (£1,481,000 serious and £342,000 slight), i.e. £182,000 per annum casualty costs.

	Saving		No saving		£000 saving		Total
Option	KSI	Slight	KSI	Slight	KSI	Slight	£000
1 Do Nothing	0	0	8	24	*-1481*	*-342*	*-1,823*
2 Compact on road	7	10	1	14	1,296	200	1,438
3 Compact off-road	5	9	3	15	926	214	1,140
4 Circulatory annular	3	2	5	22	556	28	584
5 Spiral annular	6	10	2	14	1,111	200	1,059
6 Signalised	6	10	2	14	1,111	200	1,311
7 Turbo-roundabout	6	10	2	14	1,111	200	1,311

Road		**No.**	**P**	**PC**	**MB**	**Car**	**L**	**Type**	**Factor**	**2**	**3**	**4**	**5**	**6**	**7**
Union St	In/c	0003		**Y**		n		Side	Car in hit PC c – dark	Y	Y	?	Y	Y	Y
Union St	In/c	0191		**Y**		n		Side	Car in hit PC c – dark	Y	Y	?	Y	Y	Y
Union St	In/c	1432				**D**n		Side	Car c hit Car in - wet	Y	Y	?	Y	Y	Y
Union St	In	3467				**PPP** n		Shunt	Car&Car in – Car assumed Car2 would move forward	Y **Y**	Y **Y**	?	Y **Y**	Y **Y**	Y **Y**
Union St	In/c	1115			**Y**	n		Side	Car in hit MB c	Y	Y	?	Y	Y	Y
Union St	Out	0484	**Y**			n		Hit	CarD blinded by sun hit Px	Y	Y	Y	Y	Y	Y
Union St	in/c	2414				**D**n		Side	Car2 c hit stationary car1 in	?	?	?	?	?	?
Union St	Out	0484	**Y**			n		Hit	Car hit Px - dark	Y	Y	Y	Y	Y	Y
Union St	In/c	0425			**Y**	n		Swipe	Car C hit MB in - dark	Y	Y	?	Y	Y	Y
Tavistock St	In/c	0497			**Y**	n		Side	Car in hit MB C	Y	Y	?	Y	Y	Y
Tavistock St	In/in	1190			**Y**	n		Swipe	Car in hit MB in – dark, alcohol?	N	N	N	N	N	N
Tavistock St	Out	2398				**P**n		Solo	Lost control – speed and youth	?	?	N	?	?	?
Tavistock St	Out2	1013				**D**n		Shunt	Car turning into Tavistock Place	N	N	N	N	N	N
Tavistock St	In3	0142				**DDP**		Shunt	Slow on approach	N	N	N	N	N	N
Roff Ave	In	3314	**Y**			n		Ht	Car in hit Px – P American	Y	Y	Y	Y	Y	Y
Roff Ave	Out	1663	**Y**			n		Hit	Car out hit Px	Y	Y	Y	Y	Y	Y
Roff Ave		1335				**DD**		Front	Car in lost control and hit car out	N	N	N	N	N	N
Clapham Rd	In/c	3140				**P**n		Brake	Car in mistook intention of car c	Y	Y	N	Y	Y	Y
Clapham Rd	C	0228	**Y**			n		Swipe	Drunk P steps off central island	?	?	N	N	?	?
Clapham Rd	In/c	2894		**Y**		n		Side	Car in hit PC c (no lamp) – dark	Y	Y	N	Y	Y	Y
Clapham Rd	In2?	1750		**Y**		n		Swipe	?Car in hit PC in	?	?	?	?	?	?
Clapham Rd	In/cx	2847		**Y**		n		Side	Car in hit PC cx on arm	Y	N	Y	Y	Y	Y
Clapham Rd	In	0162	**Y**				n	Hit	Lorry hit Px	Y	Y	Y	Y	**Y**	Y
Clapham Rd X	Out	1748	**Y**			n		Hit	Px at green, CarD didn't stop	N	N	N	N	N	N
Clapham Rd X	In	0428	**Y**		n			Hit	Px near lights	N	N	N	N	N	N
Clapham Rd X	Turn	2323		**Y**		n		Side	Car turned out of side rd hit PC	N	N	N	N	N	N
Clapham Rd X	Turn	2583		**Y**		n		Side	PC drunk out of side hit by Car	N	N	N	N	N	N
Total Injured	**32**		**8**	**7**	**4**	**13**			**27 accidents & 32 casualties**						
Total not hurt					1	23	1		Car drivers in all but 2 accidents						
Union St	**11**		**2**	**2**	**2**	**5**									
Tavistock St	**7**				**2**	**5**									
Roff Ave	**4**		**2**			**2**			Extra: Car out/PC circulating			N			
Clapham Rd	**6**		**2**	**3**		**1**			Extra: Cyclist crossing on Zebra		N				
Clapham Rd X	**4**		**2**	**2**					Extra: PC/driver ignoring lights					N	

Accident Data Key:

Column 1: location

Column 2: Typology: out = exit from roundabout, in = entry into roundabout, c = circulating, x=crossing

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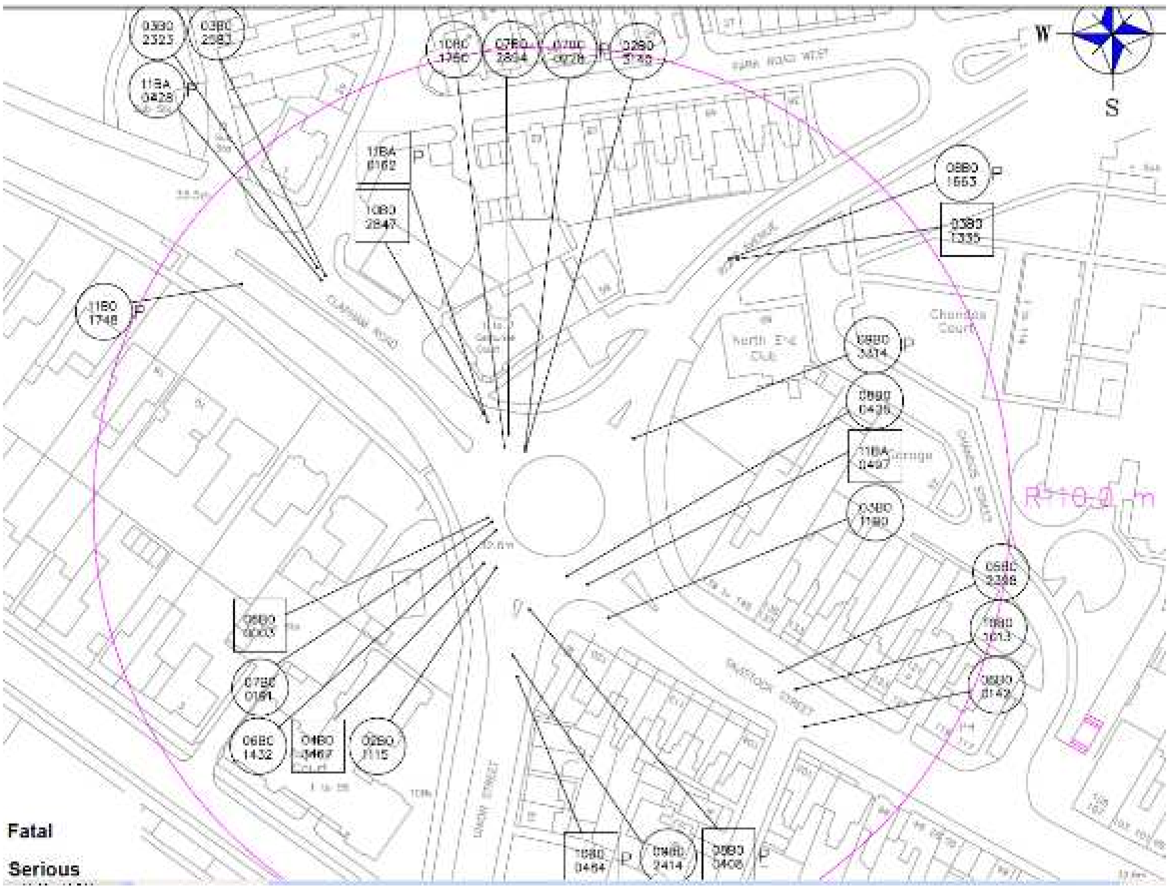
Column 3: Reference number
Columns 4-8: Mode: P = pedestrian, PC = pedal cyclist, MB = motor biker, Car = D=driver/P=passenger), L = lorry driver; **Bold casualty**, **Red serious**. Y=hurt, n=not hurt
Column 9: Where or how hit
Column 10: Additional factors
Columns 11-13: Whether proposals likely to prevent accident:
Option 2 Compact, Option 3 compact with cycle tracks, option 4 annular cycle lanes, option 5 spiral with cycle lanes, option 6 signalisation, option 7 turbo-roundabout
3 answers: **Y** = yes or **?** = possibly or **N** = no (or blank not relevant)



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Annex C Preliminary Costings

Item	Unit cost	Total
Install 100 m2 full depth footpath construction	29.18	2,918
Install 8 Zebras crossings	15000.00	123,000
All 300m2 full depth footpath constructions	32.90	9,870
Planting:		10,000
Safety audits		5,000
Topo Survey		2,000
Utilities - no allowance		
Resurfacing of roundabout		
Plane out at 2000 m2 @ 100mm	1.60	3,200
100mm carriageway construction 2000m2	17.95	35,900
Lining		10,000
Roundabout Inner island		
Removal of 20m kerb	6.80	136
Excavate and dispose 20m3 earth	55.90	1,118
Install 20m kerb	24.65	493
Install 20m2 full depth construction	79.19	1,583
Relocate signs & electrics		5,000
Imprint area as over-run		2,000
Islands		
Remove 100m kerb	6.80	680
Remove 4 bollards and signs	1000.00	1,000
Rmoved 20m3 footpath	71.80	1,436
Install 250m kerb	24.65	6,162
Install 8 bollards and signs		8,000
High Friction Surfacing	12.80	10,000
Construction Estimate		239,496
Prelims at 10%		26,731
ES fees		30,000
Total		**296,227**