



Belrobotics

Leader in automated golf driving ranges

1	<i>Introduction to golf, practice, configurations and operations</i>
2	<i>Selling arguments for an automated balls collection system</i>
3	<i>Two main categories of solutions</i>
4	<i>Ground quality requirements. Assessment. Solutions</i>
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Belrobotics

Leader in automated golf driving ranges

1

Introduction to golf, practice, configurations and operations

a.

Introduction to golf market

b.

Golf practices

c.

Economics and HR Management of a golf practice

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THE GRASS MASTERS

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Country statistics: Affiliated players and regular golf courses in Europe, 2013

Country	Players	% Change from previous year	Courses	% Change from previous year	Participation rate	Population per golf course
UK & Ireland****	1,252,836	-0.9%	2,984	-0.2%	1.85%	22,711
Germany	635,097	1.7%	719	0.4%	0.78%	113,830
Sweden**	491,401	0.0%	454	0.0%	5.18%	20,887
France	422,761	1.1%	583	0.7%	0.65%	112,054
Netherlands	388,493	1.8%	229	8.5%	2.32%	73,058
Spain	313,787	-3.5%	345	-2.0%	0.68%	133,902
Denmark	152,972	0.1%	188	1.1%	2.74%	29,684
Finland	144,221	0.2%	129	0.0%	2.67%	41,870
Norway	110,362	-3.4%	177	1.7%	2.21%	28,169
Austria	104,736	0.4%	156	3.3%	1.24%	54,122
Italy*	101,817	0.0%	278	0.0%	0.17%	218,779
Switzerland	85,758	3.6%	95	0.0%	1.08%	83,733
Belgium	57,074	1.1%	80	5.3%	0.51%	138,686
Czech Republic	55,547	4.9%	96	3.2%	0.53%	109,432
Iceland	16,641	3.7%	65	-1.5%	5.21%	4,917
Portugal	14,198	-3.3%	87	1.2%	0.13%	121,171
Slovenia	8,762	3.1%	13	0.0%	0.43%	158,115
Slovakia*	7,200	0.0%	14	0.0%	0.13%	386,023
Turkey*	5,649	0.0%	20	0.0%	0.01%	3,736,213
Luxembourg	3,890	-3.0%	6	0.0%	0.74%	87,476
Poland*	3,008	0.0%	27	0.0%	0.01%	1,427,350
Estonia	2,247	9.0%	8	0.0%	0.17%	167,458
Greece	1,830	2.8%	8	0.0%	0.02%	1,411,258
Cyprus	1,464	13.1%	10	0.0%	0.17%	86,201
Hungary	1,419	-30.0%	15	7.1%	0.01%	663,849
Latvia**	900	0.0%	3	0.0%	0.04%	680,588
Bulgaria	639	42.0%	7	0.0%	0.01%	1,046,746
Serbia	618	40.5%	2	0.0%	0.01%	3,620,648
Romania***	551	0.0%	4	0.0%	0.00%	5,338,962
Croatia***	550	0.0%	3	0.0%	0.01%	1,466,050
Lithuania	500	48.4%	6	0.0%	0.02%	501,293
Europe total	4,386,928	0.1%	6,811	0.4%	0.73%	88,543

Introduction Golf market

- There are more than 46 million golf players in the world: 28,6 m in USA/CDN, 4,4 m in Europe and 13,5 m in the rest of the World.
- This makes golf the most practiced sport in the world!
- Golf players are on average mature people, demanding in terms of quality and service.
- Growth of golf courses has slowed down in USA and Europe over the last 8 years and competition has been increasing between golf clubs: they must get more attractive, and do more with less money. This creates opportunities for productivity systems like robots.

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Introduction

Critical role of the golf practice

- « Golf practice » is the generic term to define the training area for golf players. Such practice usually comprises
 - A driving range where players exercise the "drive" or "full swing" with a wood or long iron club: balls are typically hit over distances from 100 to over 200 meters. The driving range may be used as well for "approach" or "3/4 swing" where precision is more important than distance: balls are typically hit over distances from 10 to 100 meters. Balls are provided by the Golf practice against a fee.
 - A chipping area where players "chip" or "half-swing » to simulate short-distance shots near the green, with high-lofted irons and wedges. Balls are either provided by the practice (and are collected by an operator) or by the player who collects his balls.
 - The putting green is used to exercise "putt": the goal of the putt is to put the ball in or at closing distance to the hole. Players use (and collect) their own balls.

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Introduction

Categories of golf practices

- A Golf Practice can be either
 - a section of a comprehensive golf club: players come to take lessons with Pros, to exercise on their own (without going to the golf course afterwards), or to warm up before going to the golf course: players usually hit between 50 and 100 balls per lesson- or exercise- session but only 24 balls to warm up.
 - an autonomous infrastructure without golf course: players come to take lessons and to exercise for 30' to 60'. Players usually hit more balls per exercise session than in golf clubs. These practices are open from 09:00 till 22:00 and provide customers with a bar, a snack/tavern room, and a golf boutique offering quality equipment.

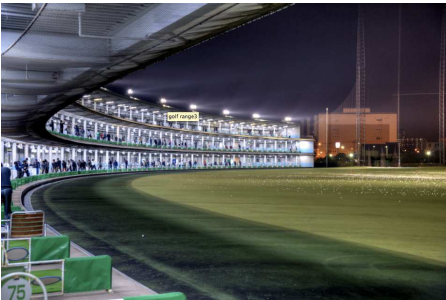
Some golf practices propose « evening-out » sessions for groups of non-golf players: such golf entertainment complexes have bays fitted with cameras, radars and animation screens to feature individual and team scores. This category is gaining in popularity in USA/CDN and in the UK. The market leader is TopGolf www.topgolf.com. TopGolf invests \$19 millions per complex where more than 60.000 balls are hit on a daily basis.

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Introduction to golf practices

All sizes: from a few bays (4), usually 12-24, a few huge ones





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Introduction to golf practices

Covered/open-air bays, mobile grass bays with possible cables





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Operations on a golf ball practice

Mow the outfield, Pick -> Handle -> Wash balls, Fill balls dispenser

1. To Mow the outfield

- Pre-condition: all balls must be collected before mowing operation: balls left on the practice would be damaged (cost) and be projected by cutting blades of rotary mowers (very dangerous)
- Consequence: the practice is closed for the picking and mowing cycle
- Mowing takes place with a rotary or a cylindrical mower. To maintain a stable grass height, mowing should repeat every 3 days

Operations on a golf ball practice

Mow the outfield, Pick -> Handling -> Wash balls, Fill balls dispenser

2. To pick, handle, wash balls and fill balls dispenser

- There are three ways of collecting balls, depending on the outfield condition (surface quality, slopes, wetland areas)
 - a. Using motorized ballpicker – pushed by a mule (see next slide)
 - b. Using a manual ballpicker pushed by an operator (see next slides)
 - c. Concentrating balls one by one using a golf club and then collecting them with a manual ballpicker (see next slides)
- As well, there are three main ways of unloading balls into the next equipment (washer or balls dispenser) – see next slides
 - a. Motorized baskets of the ball picker (most sophisticated system)
 - b. Manual handling of the balls down to a ball pit (moderately tedious)
 - c. Manual lifting of the baskets into the ball dispenser (very tedious)

Motorized ball picking operations

Large ball pickers pushed by mules/tractors/golf cars/road cars

Large ball pickers to be used in combination with motorized mules. Usually available in several capacities, some models featuring motorized unloading (see next slide):

- 3 gangs, 6 baskets, 2.400 balls, 2,6 m wide
- 5 gangs, 10 baskets, 4.000 balls, 4,3 m wide (model illustrated below)



Manual ball picking operations

Models of hand pusher pickers – typically 250 up to 800 balls capacity

Picks up balls along fence line and practice areas. Basket holds 250 balls. One basket full of clean balls is 15 kg



3 ft hand pusher picker for hard to pick areas. Basket holds 400 balls. One basket full of clean balls is 25 kg.



Manual push picker to pick balls in hard to reach and confined areas: putting green, chipping area, near trees, fences and wetlands. Offered in a One-Basket and Two-Basket configuration. Each basket holds 400 balls.



Tedious ball picking process because of poor outfield quality

Sidcup Outfield, UK (45 bays. Open 09:00 am till 10:00 pm. Up to 35.000 balls/day)



Step #1: manual gathering of balls with a golf club. 3 to 5 operators for 2 to 3 hours in early morning (the range operates from 09:00 am till 10:00 pm)



Step #2: picking balls into a basket with a manual ball picker and rolling the ball picker loaded with balls to the nearby trailer



Step #3: Stacking baskets onto the trailer. 400 to 600 balls per basket, meaning 20 to 30 kg to lift (46 g/ball)

Step #4: Transport balls and handle them into the washer and/or into the balls dispenser



Handling golf balls

A very tedious process: 10.000 balls/day = 460 kg weight lifting/day!



- Would you like to do this job all year long?
- Lifting baskets of golf balls to belt height?



Handling golf balls

A very tedious process: 10.000 balls/day = 460 kg weight lifting/day!



- Or even worse:
- Lifting baskets of golf balls to the top of the balls dispenser?

Large custom ball management systems

Only affordable to range featuring more than 35.000 balls/day



Large custom ball management systems

Only affordable to range featuring more than 35.000 balls/day

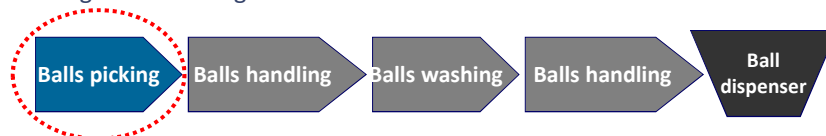


The typical end-user budget for one "all-in" ditch (pit, pre-washing, washer, blower) and a transportation system over up to 100 meters to existing ball dispensers is between 30.000,-€ and 45.000,-€. Illustrations above are from Oxland, NL. Very few driving ranges afford themselves such configurations – it is a very small niche in a niche market.

Operations on a golf practice

Preliminary conclusions

1. Operations do not limit to mowing and picking: you must see balls collection as a part of an integrated process of mowing the outfield, collecting, handling, washing and returning balls.



2. These operations go on 7 days/week, at least 9 months/year with peak weekends and low days (week days), in peak months (spring, summer) and low months (fall, winter): this requires effective and agile human resources management.
3. Last, operations vary substantially between dry summer (dry ground – heavy equipment do the work) and adverse weather (wet or very wet grounds – manual operations, sometimes ball per ball).
4. Remember a robot can hardly do better than a man: that means an automatic Ballpicker may be unable to operate in adverse weather conditions, typically in very wet conditions, with water and mud on the ground surface

Operations on a golf practice

Preliminary conclusions: what does this mean to us?

1. *Comprehensive process*

Our offer must include considerations for downstream processes: balls handling, balls washing and balls handling back to the ball dispenser. If we fail to facilitate these operations, the pay-back of the Bigmow and the Ballpicker will be harder to justify.

2. *Quality (drainage) of the outfield is essential*

The effectiveness of the balls collecting process very much depends on the quality of the ground, and specifically, the quality of drainage. It is essential to ensure there will be not wetland areas (the Ballpicker cannot operate on very wet grounds), limiting mud and tracks to an acceptable level.

3. *Sometimes, they only way to go is to go manually*

People tend to believe robots can cope in adverse situations where men can't. Remind prospects that a robot can hardly do as well as a man: when manual picking is the only way to collect balls on very wet ground, it is likely that the Ballpicker will not be the right option in similar circumstances. The only way is to make sure the drainage is fit to purpose, not the robot.

Introduction to golf practice operations

Economics and HR Management of a Golf practice - Revenues

Revenues vary with the number of balls played. Here are a few reference data to simulate revenues of a driving range (excl. Food, beverage, Pro-lessons, etc.):

- Each mat (bay) usually welcomes between 5 and 10 players per day during summer. Each player plays about 30', meaning each mat is used between 2,5 and 5 hours/day
- A player hits between 50 and 100 balls per 30' session. Hence: minimum $5 \times 50 = 250$ balls/mat/day and maximum $10 \times 100 = 1.000$ balls/mat/day. Experience suggests to consider **350 balls/mat/day on average during summer**
- Price paid by player varies between 2,0 € and 4,0 € per 50-ball basket (**6 c€/ball on average**). Hence daily revenues during summer between 15,-€ and 60,-€. Let's consider an average of $3,0 \text{ €} \times 350/50 = 21 \text{ €/mat}$

# bays	Min. # balls (weekday)	Average # balls	Max. # balls (weekend)	Weekday Rev.	Average Rev.	Weekend Rev.
12	3.000	4.200	12.000	180,-€	252,-€	720,-€
24	6.000	8.400	24.000	360,-€	504,-€	1.440,-€
36	9.000	12.600	36.000	540,-€	756,-€	2.160,-€

Introduction to golf practice operations

Economics and HR Management of a Golf practice – Collection costs

Collection costs have fixed (equipment, FTE wage) and variable (fuel, temp wages, lost balls) components. Experience suggests that the cost of collecting, handling, washing and returning balls to the balls dispenser vary as follows:

- Summer period – dry ground – motorized ballpicker, no washing: **0,5 c€/ball** (about 10% of revenues per ball). Please note that collection cost/ball is higher in small ranges
- Winter period – semi-wet to wet ground – motorized/manual ballpicker, washing: **up to 1,5 c€/ball** (about 25% of revenues per ball)

# bays	Average # balls/day	Average Rev./day	Average collection cost per day (Summer)	Average collection cost par day (Winter)
12	4.200	252,-€	21,-€	63,-€
24	8.400	504,-€	42,-€	126,-€
36	12.600	756,-€	63,-€	189,-€

- Note: these are average values: the collection costs, in c€/ball, are higher in weekdays (standard wage but few balls) and lower in weekends (higher wage but more balls)

Introduction to golf practice operations

Economics and HR Management of a Golf practice – HR considerations

Managing human resources of the driving range is not an easy process:

- Variable resources over the week: volumes vary from 1 to 3 between weekdays and week-end. Ranges need more resources during WE when overtime pay is mandatory. A solution is to used students, but students are less reliable than Full Time Employees and need breaks for study/exams periods.
- Variable resources over the year: volumes vary from 1 to 2 between summer and winter. However, balls are easy to collect and handle in the summer (moderate work), while the fewer balls hit during winter are dirty, clogged in the mud and require washing (hard work).
- Work can be tedious in the winter: work in the dark, under the rain, on wetlands, unclogging balls, more handling to wash balls, etc. Operators ask for a premium due to hard work conditions, that may be found too expensive by the owner who prefers to carry this work himself ... defocusing him from its key tasks.

This explains why the **convenience of delegating work to robots is a key selling argument**, as strong as the financial one!

We come back to these selling arguments in the next section.

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1	<i>Introduction to golf, practice, configurations and operations</i>
2	<i>Selling arguments for an automated balls collection system</i>
a.	<i>Economical: cheaper than manual operations</i>
b.	<i>Convenience: easy to manage throughout weekdays and weekends</i>
c.	<i>Nicer grass and progressive image</i>

Selling arguments for golf practice automation

2 major selling points out of our 4 regular ones



perfect lawn

hill 4.000 m² hill 10.000 m² hill 20.000 m²

www.belrobotics.com



50% savings

hill 4.000 m² hill 10.000 m² hill 20.000 m²

www.belrobotics.com



- 90% CO₂ emissions

hill 4.000 m² hill 10.000 m² hill 20.000 m²

www.belrobotics.com



less labour, less stress

hill 4.000 m² hill 10.000 m² hill 20.000 m²

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Cost savings from golf practice automation

Not considering possible ground, layout & equipment improvements

- Consider the scope of what is automated
 1. Mowing the outfield
 2. Collecting balls (at least 95% of them)
 3. Transferring, washing and putting balls back in the dispenser
- Experience suggests that
 - All in all, automating tasks 1 (Mowing) and 2 (Collecting balls) allows **to save about 20.000,-€ to 25.000,-€/year** in labour, balls buried in the ground, no revenues during collecting-mowing sessions, etc.
 - When the whole process is automated, **savings can reach 40.000,-€/year**: the incremental saving is on labour required before to handle, wash, transfer balls – which is both costly and tedious
- In terms of pay-back
 - Automating tasks 1 (Mowing) and 2 (Collecting balls) **pays-back in 2 years**
 - Automating the full process **pays-back in 1,5 year**

Less labour, stress and hassle

Alleviate or eliminate tedious human operations

- Think of the process
 - To handle 10.000 balls/day, which is 460 kg weight lift/day
 - Even more tedious when balls need be lifted to shoulder height into the ball dispenser, and all this in all weather conditions
- Think of the management effort to have
 - Trustable people on the outfield (no absenteeism, using equipment with care, following safety instructions)
 - Available at required times of the day, across the week and weekend
 - In all four seasons
- **The above two elements are often as convincing as the financial point to go for an automated driving range!**
- Plus usual selling points
 - Improved grass quality thanks to continuous micro-mulching
 - No interruption of service, silent operation, no balls buried in the ground (that pollute ground), progressive image of the golf club

Belrobotics

Leader in automated golf driving ranges

1	<i>Introduction to golf, practice, configurations and operations</i>
2	<i>Selling arguments for an automated balls collection system</i>
3	<i>Two main categories of solutions</i>
a.	<i>Basic technical concepts</i>
b.	<i>Mowing the outfield, collecting balls, manual retrieval</i>
c.	<i>Mowing the outfield, collecting and transferring balls to the dispenser</i>
	<i>Direct transfer of balls from the drop pit to the washer/dispenser</i>
	<i>Hydraulic transfer from the drop pit to the washer/dispenser</i>
	<i>Pneumatic transfer of balls from the drop pit to the dispenser</i>

It takes two to tango: Ballpicker & Bigmow

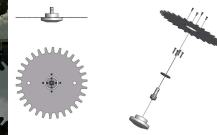
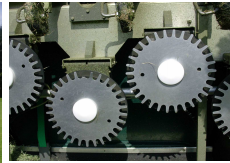


- The Ballpicker tirelessly and silently, picks up golf balls without pressing them into the ground and then returns them to a drop pit
- The Bigmow simultaneously cuts the driving range, lifting the balls away from the cutting heads to keep them intact

The typical end-user budget for one Ballpicker + one Bigmow + one wooden ditch + one 2,0 m lift + standard installation, excluding mains supply, ground works and remodelling, dedicated shelter, etc. is 30.000 €.

It takes two to tango – the Bigmow

Bigmow cuts grass, preserves balls and improves grass quality

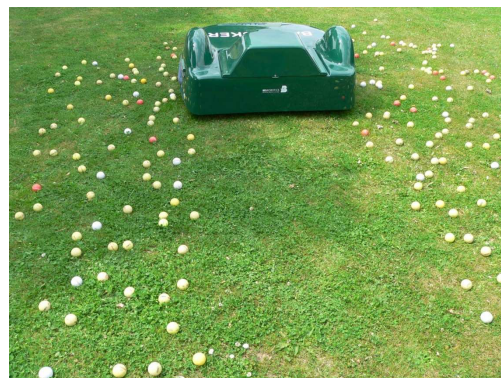
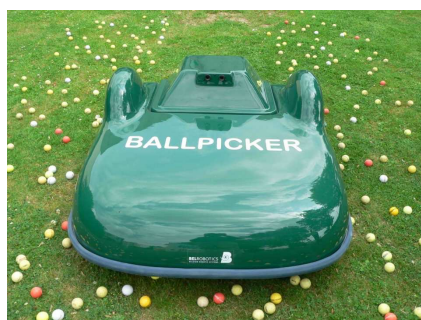


Golf balls are kept away from cutting blades by special protection disks that replace the regular anti-friction disks. (Kit BR 12387)

- The Ballpicker works 24/7. It leaves uncollected balls on the driving range, that should not be collected manually: this would reduce balls density, hence decreasing the Ballpicker performance. While the Bigmow and the Ballpicker work concurrently 24/7, manual mowing requires all balls are collected before mowing, which is sub-optimal with Ballpicker operation.
- The Ballpicker gets clogged by grass depots on practices in rainy environment that are not mowed on a regular basis. In such environment, the Bigmow is essential to the Ballpicker.

It takes two to tango – the Ballpicker

Ballpickers tirelessly pick up balls and return them to the drop pit



When the reservoir is full, the Ballpicker goes back to the unloading station and drops collected balls in a pit



Ballpicker
Technical data



	Ballpicker
Nominal speed	3,6 km/h
Maximum slope	30%
Battery capacity	15 Ah
Consumption	500 kWh/year
Bodywork	Polyester fibres
Sound level (to 1 m)	< 65 dB
Dimension L x w x h	130 x 120 x 50
Weight	60 kg (empty)
Balls reservoir	300 balls (15 kg load)
Collection capacity	Up to 12.000 balls/day, density dependent
Communication	Track & Trace (SMS & remote control)
Range size	Up to 20.000 m² per Bigmow and per Ballpicker

Collection capacity of the Ballpicker

Best practices

Collection capacity of the Ballpicker	How to optimize collection capacity?
= Width	Check for debris and depots that could block collection capacity. Once a day
x Speed	Reduce travel distances by setting the unloading station close to the higher density zone on the practice
x Balls density	- On very large driving ranges (> 20,000 m²) where density is an issue, implement a two-zone system - Do not collect balls manually, even on busy days. Make sure enough balls are available in the ball dispenser(s)
x Working time	- The normal operation schedule of the Ballpicker is 24/7 - On a two-zone system, the Ballpicker focuses on the higher density zone during peak schedule (max. 4 hours/day) and the other one during off-peak hours

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Where to locate the drop pit?

Reference site: Four Ashes Golf Centre, Solihull, UK



The image is an aerial photograph of the Four Ashes Golf Centre. A yellow dashed line outlines a large area of the golf course. A red location pin labeled 'A' is placed on the map. A blue arrow points from the top right towards a specific area on the golf course, likely indicating the recommended location for a drop pit. The text 'Four Ashes Golf Centre' is visible on the map. A copyright notice '© 2013 Google' is also present.

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Where to locate the drop pit?

Discussion

	Drop pit located close to the bays	Drop pit located far from the bays
Pro's	• Only solution when balls are retrieved manually at the drop pit (see next slides) • Only solution to transfer balls to washer/dispenser (close to the bays) when using lifts/conveyors	• Tracks are out of sight. Neat outfield • Perturbations (movements, noise) are kept remote from players • The drop pit is closer to the high density area
Con's	• BP goes to drop pit 30 to 50 times a day, leaving visible tracks alongside the wire and next to the drop pit. Those tracks are close and visible from the bays • The movements of the BP and the noise of the transfer system distract players • BP takes a long journey to the drop pit, which is remote from the high density area	• An hydraulic or a pneumatic transfer system is mandatory, to transfer balls over distances from minimum 20-30 meters to ideally 50 to 100 meters between drop pit and washer/dispenser

Conclusion: a drop pit away from the bays coupled with an automatic ball transfer system is a far better solution, economically and technically speaking

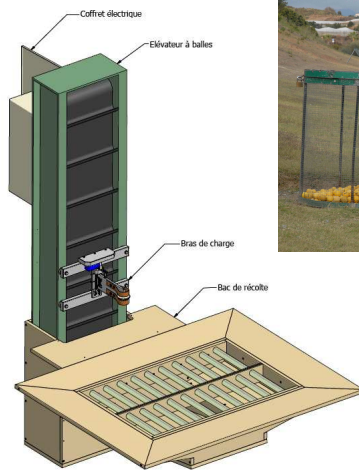
Where to locate the drop pit?

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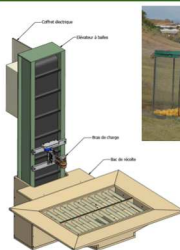
Drop pit and balls lift

Simplest configuration: wooden pit, lift, and receiving basket



Collection ditch and balls lift

Simplest configuration: wooden pit, lift, and receiving basket



This is not enough!

- This simplest configuration does not create enough value for the driving range operator:
 - the pit is too close to the bays: the Ballpicker distracts players and leaves marks on the ground near the bays
 - the handling work is tedious for operators, sometimes even more tedious than with their current motorized ballpicker
 - Economically speaking, we only eliminate the collection part of labour
- Experience shows this is not a viable solution in the long run!

Integrated solution: mowing the outfield, collecting, transferring, washing and returning balls to the dispenser

Let’s review most common solutions used with Belrobotics’ Ballpicker

1.	Direct transfer of balls from the drop pit to the nearby washer and/or the dispenser	• Custom solution c/o installer or driving range • Improved wrt simplest solution but not ideal: the drop pit is still close to the bays and lifts involved
2.	Hydraulic transfer of balls from the drop pit to the technical room equipped with washer and/or the dispenser	• Custom solution with civil works c/o driving range • Significantly better than direct transfer: the drop pit is 30 ro 50 meters from the bays. Lift(s) are still required at the end of the transfer pipe
3.	Pneumatic transfer of balls through a flexible pipe to the technical room. Balls wash on their way from the drop pit to the dispenser	• Product-based solution: drop pit, water separator, distributor and control system are sourced from Robotech Automazioni (Italy) • Very versatile in installation • Almost ideal: remote drop pit, no lift • Going-on improvements: cleaning, rinsing, operation in freezing temperatures

Integrated solution: mowing the outfield, collecting, transferring, washing and returning balls to the dispenser

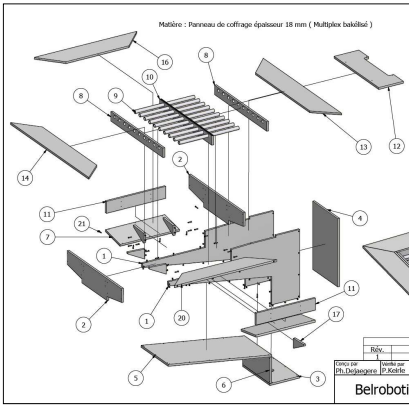
Let’s review most common solutions used with Belrobotics’ Ballpicker

4.	Pneumatic transfer of balls through a flexible pipe from the technical room (located away from the bays) to the ball dispenser (located next to the bays)	• Balls need be washed before being flushed into the pipe by a blower • Standard products and solutions available from vendors (Range Servant, Range King, etc.) • Very versatile in installation



Drop pit and direct transfer via ball lift
Inexpensive 18mm wooden pit. Standard solution from Belrobotics

Matière : Panneau de coffrage épaisseur 18 mm (Multiplex bakélite)



Liste des pièces	
ARTICLE	QTE
1	2
2	2
3	1
4	1
5	1
6	1
7	2
8	2
9	10
10	1
11	2
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	4

Historique des révisions	
Révisé	Date
1	11/09/2010

Modifications et ajout de pages	
Modifié par	Modifié le
Ph. Dubois	11/09/2010

Belrobotics

Bac récepteur bois	
Quantité	Unité
1	1/10



- Inexpensive: RRRP = 1.350,-€ including surface grill.
- Satisfactory in stable ground and dry environment. Not adapted to unstable/wet grounds
- Custom-made concrete ditches, with or without polyester coating by local specialists

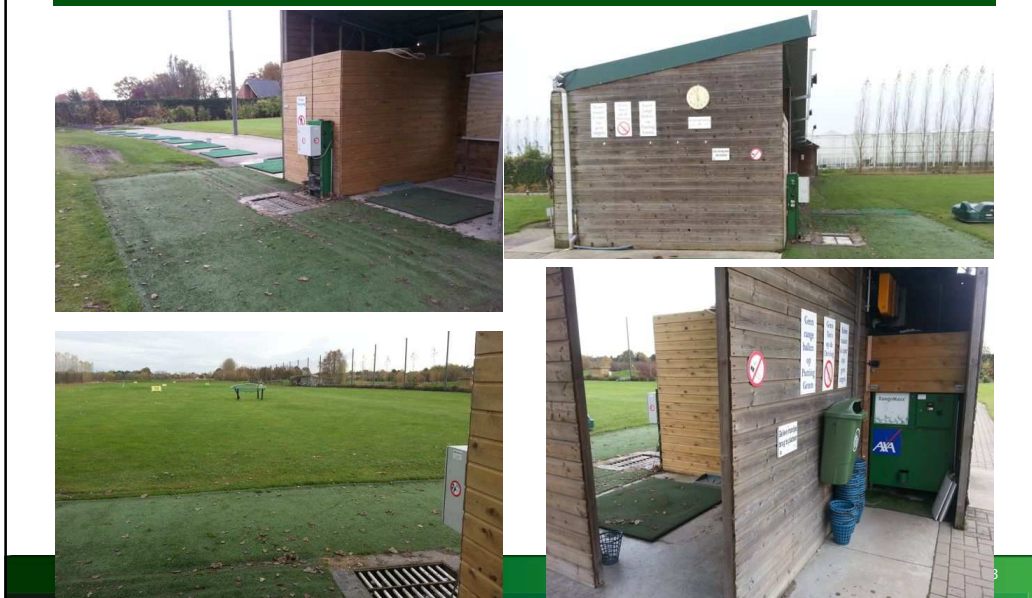
Drop pit and ball lift
Wooden pit with appropriations (7 Fontaines, B)



- 45 holes golf club with 1.800 members near Brussels
- 25.000 m² golf practice with 2 Ballpickers + 1 Bigmow
- Wooden pit implanted in a concrete excavation
- Pit located near the tees, hidden from the Club House by a fence
- Custom washing system made by the Golf Club in off-peak period
- Blower and pneumatic transport to the dispenser was planned in 2013 (not installed yet)

Drop pit & direct transfer via ball lift into the technical room

But poor location with BP passing in front of all bays at each drop (Wijnvelden, B)



Drop pit & direct transfer via ball lift into the technical room

But poor location with BP passing in front of all bays at each drop (Wijnvelden, B)

SAFETY!

Think of what may happen when a player does not see the Ballpicker approaching, hits the ball to the Ballpicker, which bounces back to head of next player ...



Drop pit & direct transfer via ball lift into the technical room Inside the technical room (Wijnvelden, B)

Balls coming from outdoor lift pass through the room wall down a gutter, into a ball washer. Upon exit from the washer, balls drop down a second gutter and are lifted into the ball dispenser on the other side of the wall



Drop pit & direct transfer via ball lift into the technical room Integrated lift/washer (Akersberga Golfklubb, SE)

Automatisk klippning och
bollplockning av driving range



Automatisk klippning och
bollplockning av driving range



Drop pit & direct transfer via ball lift into the technical room
Integrated lift/washer (Akersberga Golfklubb, SE)

Automatisk klippning och
bollplockning av driving rang



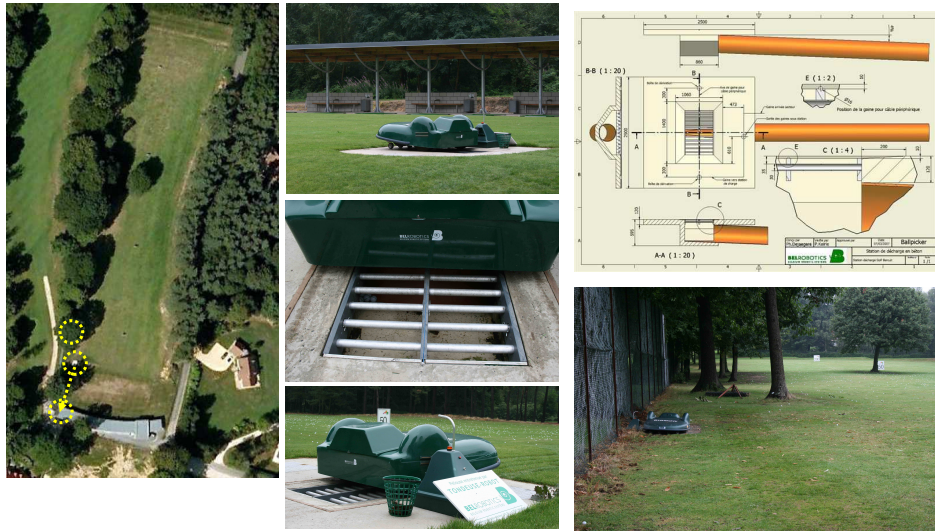
Drop pit & direct transfer via ball lift into the technical room
Integrated lift/washer (Akersberga Golfklubb, SE)

Automatisk klippning och
bollplockning av driving range



Drop pit, hydraulic transfer and two ball lifts

Custom concrete pit and hydraulic transport to washer (Bercuit, B)



Drop pit, hydraulic transfer and two ball lifts

Custom concrete pit and hydraulic transport to washer (Bercuit, B)

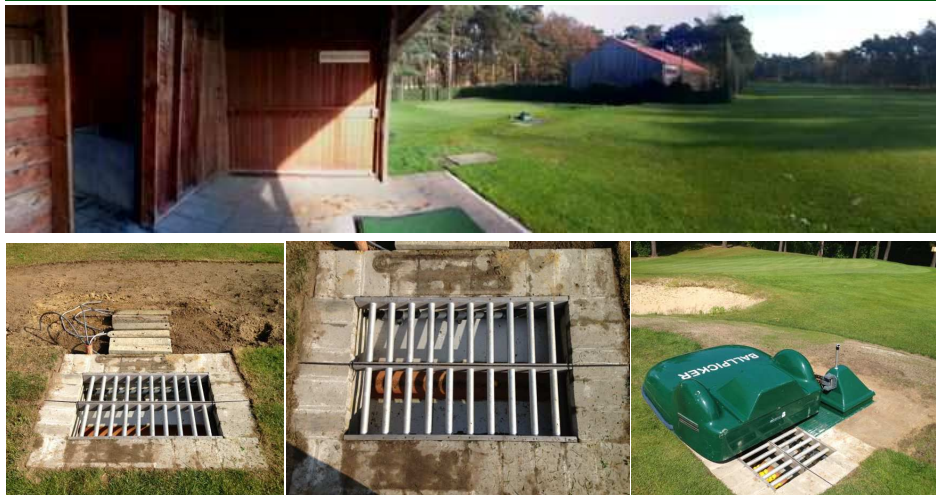


Let's get closer to the drop pit

- The drop pit is installed on a concrete foundation, that accommodates the pit and PE tube
- Balls travel in the PE tube flushed with water over 30 m down to a second pit under a small concrete building where a lift takes balls up the washer. A gutter retrieves balls from the washer, puts them into a second lift that feeds balls into the ball dispenser.
- Very solid, dependable, neat installation ... at a price!

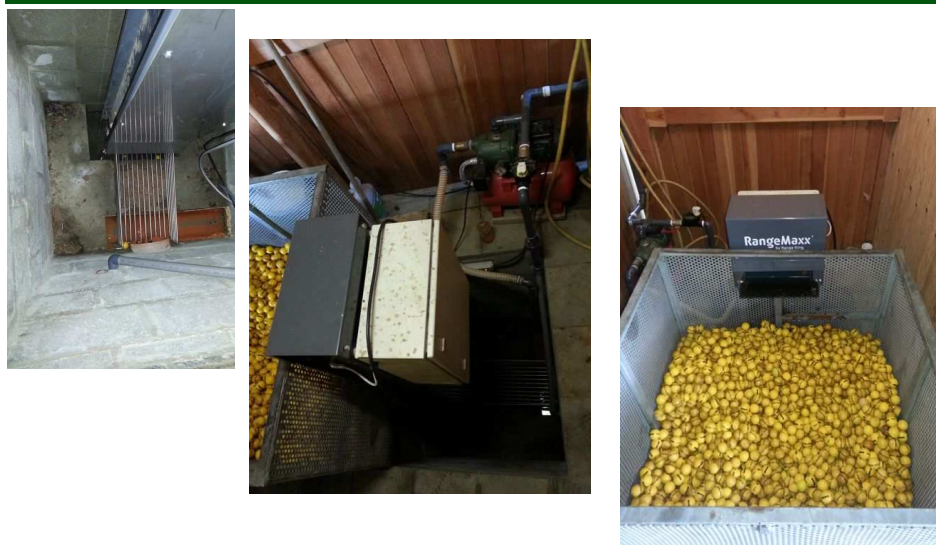
Drop pit, hydraulic transfer direct to the dispenser

Custom concrete pit and hydraulic transfer to dispenser (Houthalen, B)



Drop pit, hydraulic transfer direct to the dispenser

Custom concrete pit and hydraulic transfer to dispenser (Houthalen, B)



Drop pit, hydraulic transfer direct to the dispenser

Custom concrete pit and hydraulic transfer to dispenser (Niozelles, South of France)



Drop pit, hydraulic transfer direct to the dispenser

Custom concrete pit and hydraulic transfer to dispenser (Niozelles, South of France)



Drop pit, hydraulic transfer direct to the dispenser

Direct transfer of balls down to the dispenser (Niozelles, South of France)



Drop pit, pneumatic ball transfer, washing and return to dispenser

Operating principle: golf balls are sucked from the drop pit into a pipe



1. Balls fall into a stainless steel drop pit. There are sprayed with water and sucked at high speed into a flexible pipe to the technical room 50 to 80 m away. Balls wash on their way.



2. Balls are rinsed at constant speed in the water separator. They are counted and sent to the nearby distributor.



3. Balls accumulate in the distributor and are released by group of 250 in the ball dispenser.

4. A powerful vacuum pump (2,5 kW) sucks air from the drop pit through the entire circuit. The maximum length between the drop pit and the pump is 100 m



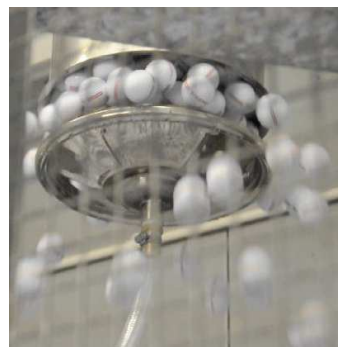
Drop pit, pneumatic ball transfer, washing and return to dispenser
Currently 6 sites in operation. 12+ new sites planned in 2014



ROBO TECH
AUTOMAZIONI

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Very flexible system. Minor improvements going on (cleaning, rinsing, operation in freezing temperature). The best companion of BP to date!



ROBO TECH
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Drop pit & direct transfer into technical room, located 50 m from the dispenser. Balls are blown in an underground pipe (Haverlij Golf, NL)



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3	<i>Two main categories of solutions</i>
4	<i>Ground quality requirements. Assessment. Solutions</i>
a.	<i>Illustrative pictures – good outfields, poor outfields</i>
b.	<i>Guide to interview greenkeepers: check ground drainage and quality</i>
c.	<i>Reinforcement alongside the wire and at the drop pit</i>

Tracks alongside the wire and around the drop pit

Featured case: Bercuit Golf, Belgium. Drop pit 30 m from the bays



All pictures of Bercuit Golf shot on Nov 20, 2013 in the wettest fall in the last 10 years, meaning these are the worst conditions

- The drop pit is hidden behind the wood panel on the left
- This picture features what players see from the bays
- Almost no tracks visible
- Neat outfield

Tracks alongside the wire and around the drop pit

Featured case: Bercuit Golf, Belgium. Drop pit 30 m from the bays



Let's get closer to the drop pit

- The drop pit is hidden behind the wood panel on the center
- Tracks are visible alongside the wire, but are quite acceptable
- No wet spots/wetlands on the range → good drainage of the ground

Tracks alongside the wire and around the drop pit

Featured case: Bercuit Golf, Belgium. Drop pit 30 m from the bays



Let's get closer and closer to the drop pit

- Tracks are marked in the vicinity of the drop pit
- Tracks are increased where the BP climbs up to the drop pit (clockwise return, S docking)
- This is acceptable as the drop pit is away from the bays. This might not be the case should the pit be close to the bays
- In this range, the BP does not collect balls in the area between the bays and the drop pit (a band 30 m wide)

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Tracks alongside the wire and around the drop pit

Featured case: Houthalen Golf, Belgium. Drop pit 30 m from the bays

All pictures of Houthalen Golf shot on Nov 24, 2013 in the wettest fall in the last 10 years, meaning these are the worst conditions. Pictures feature what players see from the bays: almost no tracks visible, very neat outfield, perfect drainage of the outfield (limestone and sand)



Tracks alongside the wire and around the drop pit

Featured case: Houthalen Golf, Belgium. Drop pit 30 m from the bays



- Tracks limited to the vicinity of the drop pit



Tracks alongside the wire and around the drop pit

Featured case: Keele, England



Tracks caused by 3 cumulative factors: (i) poorly drained outfield and near the drop pit (should have been identified before installation), (ii) extremely wet fall 2013, (iii) bad parameters setting (BP should not pass alongside bays to unload balls). Solutions: (i) drainage (planned in spring 2014), (ii) grass protection mesh near drop pit, (iii) resetting of parameters and options (done)

Wetlands, worm casts, mud allover the range. BP not used for last 2 months. Tracks made by mule and pushed picker (Elsenham, England)



Only 2 things to do

- 1. Drain the range!**
- 2. Treat worm casts preventively**



Ground quality

Worm casts





Ground quality

Worm casts

What are worm casts?

- Worm casts are made by earthworms that eat the soil, digest it and produce incredible volume of casts which are pushed up through the soil, like a mole hill. Left on the surface of the lawn, the casts will be smeared across the grass through mowing and walking. It does not take long for the surface of the lawn to become really muddy and slippery.
- The wetter the autumn or winter, the greater the worm activity will be. Increased populations can be found in heavier clay soils and wetter soils.

What can be done to control the worm activity?

- The best solution is to apply a worm cast control product such as CastClear in late September/October or when worm casts appear on the lawn. The control product does not kill the worms but creates a barrier in the soil that the worms are not keen to pass through, as the control product is an irritant to their system. The worms will stay deeper in the soil and not cast.
- The control product will last around two to three month's dependant upon the level of rainfall over the autumn/winter months. Do not spray too early in September.

What should you to do assess the ground quality?

At proposal/contract discussion time

- The best practice is
 - to conduct an interview of the owner/operator
 - to report the conclusions of the interview in the proposal/contract and to remind that the Ballpicker will not be suitable for wetlands and in presence of worm casts
- Questions to discuss in the interview
 - How do they collect balls across the year? Do they use the mule/ballpicker in fall and winter? If not, does a push ballpicker do the work? No collection in 2-steps (gathering balls with clubs and then push ballpicker)?
 - Presence of wetlands on the outfield? Where? Drainage works planned to avoid wetlands? *Check there will never be any wetland alongside the wire (the most critical zone on the outfield wrt tracks). In case of doubt, propose to appoint an expert to survey suspicious zones.*
 - Do they have worms in the outfield? Do they control of worm casts activity? When do they spray the control product? Do they repeat the operation during fall/winter?
 - Who will be in charge of daily cleaning/maintenance of the system (Ballpicker, Bigmow, Ball transfer system)? *Make sure this person is present across the week/year and is motivated to make the system work.*

Reinforcement of the ground alongside the wire

Where ground is likely to become muddy and rutted in wet conditions



- A Turf Reinforcement Mesh is ideal for grassed areas prone to becoming muddy and rutted in wet conditions.
- The turf mesh enables the grass to intertwine with the plastic mesh and stabilised the grass to create a strong reinforced grass surface.
- Do insist on reinforcing the ground preventively where it is likely to become wet in fall/winter.



Reinforcement of the ground at the drop pit location

- The Ballpicker load is between 250 and 300 balls. For a daily collection of 8.000 balls, the Ballpicker comes to drop pit 25 to 30 times a day, following the trackborder and manoeuvring exactly on the same layout near the drop pit.
- Natural grass on well drained ground will be marked with such frequency, whatever you do.

Our recommendation

- Do cover the manoeuvre area around the drop pit with a turf reinforcement mesh and an artificial turf such as AstroTurf: it can easily be cleaned, and be changed when worn.

Belrobotics

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4	<i>Ground quality requirements. Assessment. Solutions</i>
5	<i>Performance and sizing simulation. Single or double zone</i>
a.	<i>Map of the driving range. Information and key data</i>
b.	<i>Rule of thumb .vs. simulation</i>
c.	<i>Single or double zone</i>
d.	<i>Best practices</i>

Set up the map of the driving range

Measure length of peripheral wire and total area (Ref. Four Ashes, UK)



Analyse the map of the driving range

Do not cover 100% of the range if it leads to lower productivity/quality



- The yellow line corresponds to the physical limit of the driving range (see discussion below).
- After discussion with the owner, the boundary wire has been set as the red line: this area is the one actually used and comprises 99% of balls hit. Its total length is 812 meters.

The length of the peripheral wire is close to the maximum technical limit of both the BM and the BP (1.200 m) and the covered area exceeds 20.000 m². Two considerations:

- The area is too large for the BM to be fully effective. This would impact the BP productivity: grass will be torn in the balls collecting process; grass will accumulate in the BP reservoir, asking for more frequent cleaning → **do not go beyond 20.000 m²!**
- Assuming the grass is correctly mowed, the productivity of the BP would be too low because of the low density of balls → **do restrict the BP to the area most populated with balls** and use the mule Ballpicker to collect balls over the balance of the field once a week

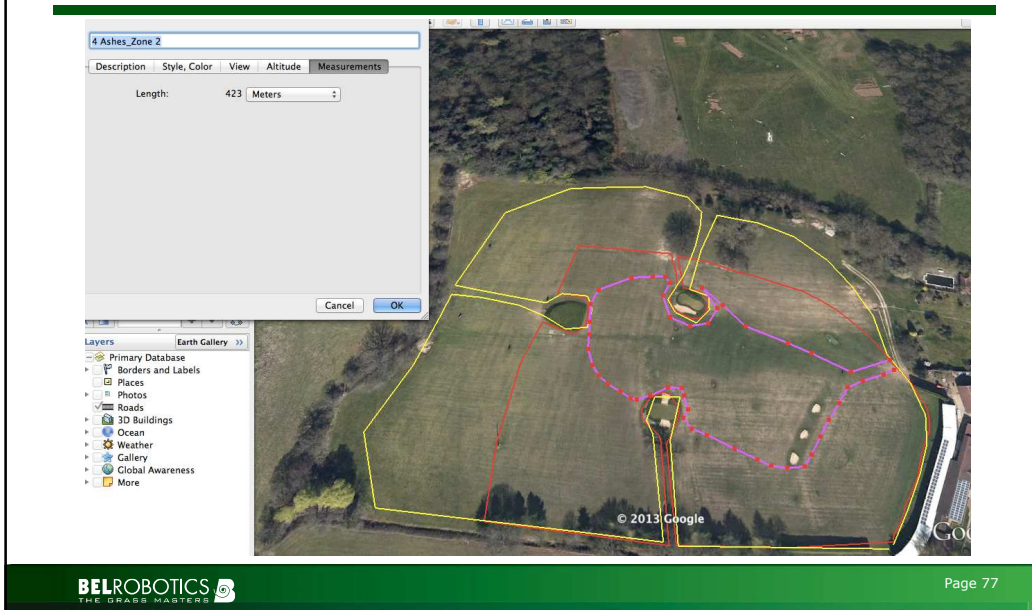
Collect information and key data

Ground quality, usage profile, 1-zone or 2-zones layout

- Ground quality: see summary slide in previous chapter (interview of the owner)
- Usage profile of the driving range. Identify:
 - The number of balls hit per weekday/weekend day in peak months (April through August in Northern Europe).
 - The quantity of balls available at the facility (= number of balls that can be hit without balls collection). Does it cover 1,5 peak day and 1 peak day followed by 1 weekday? If yes, there are enough balls. If not, additional balls need be sourced (*rule of thumb*).
 - Presence of the operator everyday to inspect and clean the BP (any time in the day, but everyday). **This is essential.** This operator should receive alarm messages of BP and BM.
- 1-zone or 2-zones?
 - Show up at different times at the range during busy days: do you see a clear high density zone (4 times higher balls density than elsewhere), that covers max. 30% of the area of the range?
 - If and only if the BP is coming close to its collection capacity (8.000 to 12.000 balls/day depending on density), consider implementing a 2-zones system.
 - An example of 1-zone and 2-zones layouts is shown on next slide

Configuration of a 2-zone system

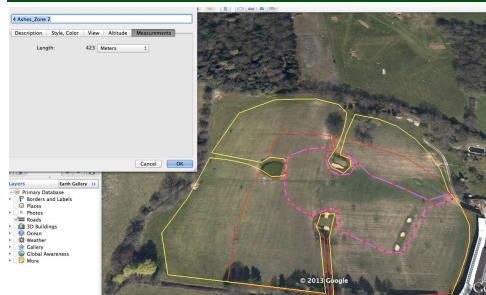
The high density zone typically is 30% of total area



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Configuration of a 2-zone system

The high density zone typically is 30% of total area



- The yellow line marks the physical limit of the driving range.
- The red line shows the limit of BM & BP operation.
- The violet line corresponds to the high density zone: **it corresponds to the area where at least two thirds of balls are being sent on a peak day**

How to implement the second (high density zone):

- Refer to the multi-zone training chapter specific to golf practices. The BM only operates on the total (outer) zone. Follow exactly specifications for wire layout and installation and guidance to set parameters/options.
- Experience shows that the **BP can operate maximum 4 hours/day in the high density zone:** going beyond would lead to « empty » high density zone and « over-populated » outer zone.
- Send the BP to the high density zone 3 hours after start of the peak period. If peak period goes from 09:00 till 17:00, make BP focus on the high density zone from 12:00 till 16:00

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5	<i>Performance and sizing simulation. Single or double zone</i>
6	<i>Configuration of the balls drop ditch: location and settings</i>
a.	<i>Location – with or without balls transfer – pneumatic or hydraulic</i>
b.	<i>Physical implantation of the drop pit</i>
c.	<i>Parameters and options of Ballpicker(s) and Bigmow(s)</i>
d.	<i>Best practices</i>



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Where to locate the drop pit? It depends on the transfer system	
• Ideally, in combination with an hydraulic/pneumatic transfer system – Locate the drop pit far from the bays (at least 30 m, ideally 50 m) – Close to the high density zone (typically spreading 75 to 150 meters from the central bays) – On the higher (drier) side of the driving range, transfer system/dispenser permitting – On well drained ground • If direct transfer or manual retrieval is used – Locate the drop pit on the side of the bays row in such a way that BP passes in front of the minimum number of bays	



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What return strategy to the drop pit?

Come and go from/to the back of the driving range

- The BP considerations define the return strategy because it travels 25 to 30 times/day to the drop/docking station, while BM is lighter and goes charging 8 times/day
- Avoid BP passing in front of bays when going back to or leaving the drop/docking station
 - Select Clockwise or Counter-Clockwise to go to station from the back of the driving range (minimizing returns alongside the bays)
 - Select « U-shape » return so that the BP leaves the station towards the back of the driving range
- This solution
 - Reduces formation of tracks alongside/near the bays
 - Reduces the travel time of the BP

What return strategy to the drop pit?

Come and go from/to the back of the driving range



- 0: Drop/docking station of BP
- 1: Docking station of BM
- Distant > 25 m one each other
- Each one on a flat plateau 5x6 m
- > 5 m straight wire before/after station

We recommend to locate all docking stations on the same side of the range

Parameters and options for above configuration

Come and go from/to the back of the driving range

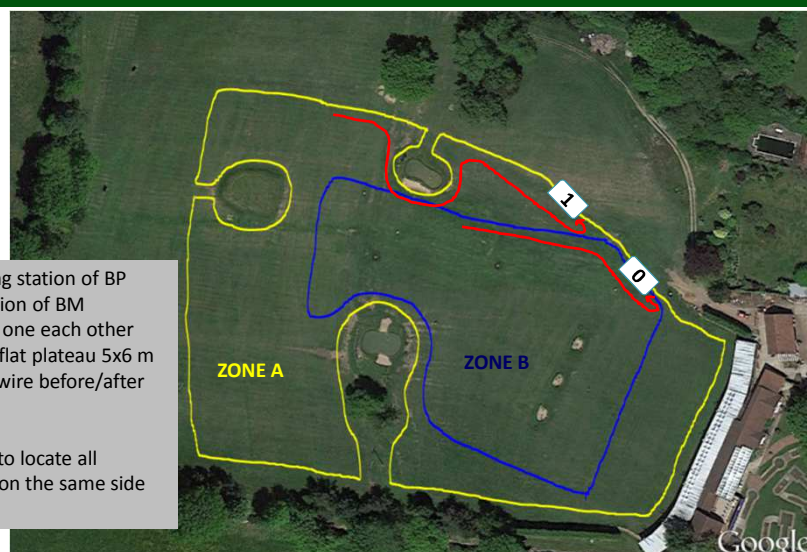
Parameters	Significations	BallPicker	BigMow
P001	Peripheral wire, length (x10m)	60	60
P002	Max distance on wire leaving station (x10m)	1	1
P003	Minimum track border segment	0	0
P004	Minimum track border line	200	200
P006	Min distance on wire leaving station (x10m)	0	0
Options	Significations	BallPicker	BigMow
O000	Multiple robots	V	V
O006	Multiple BallPicker	-	-
O010	CounterClockWise station seek	V	V
O011	Charge on 2 sides	-	-
O013	U-Shape return	V	V

What return strategy to the drop pit?

Come and go from/to the back of the driving range

- 0: Drop/docking station of BP
- 1: Docking station of BM
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Parameters for above configuration

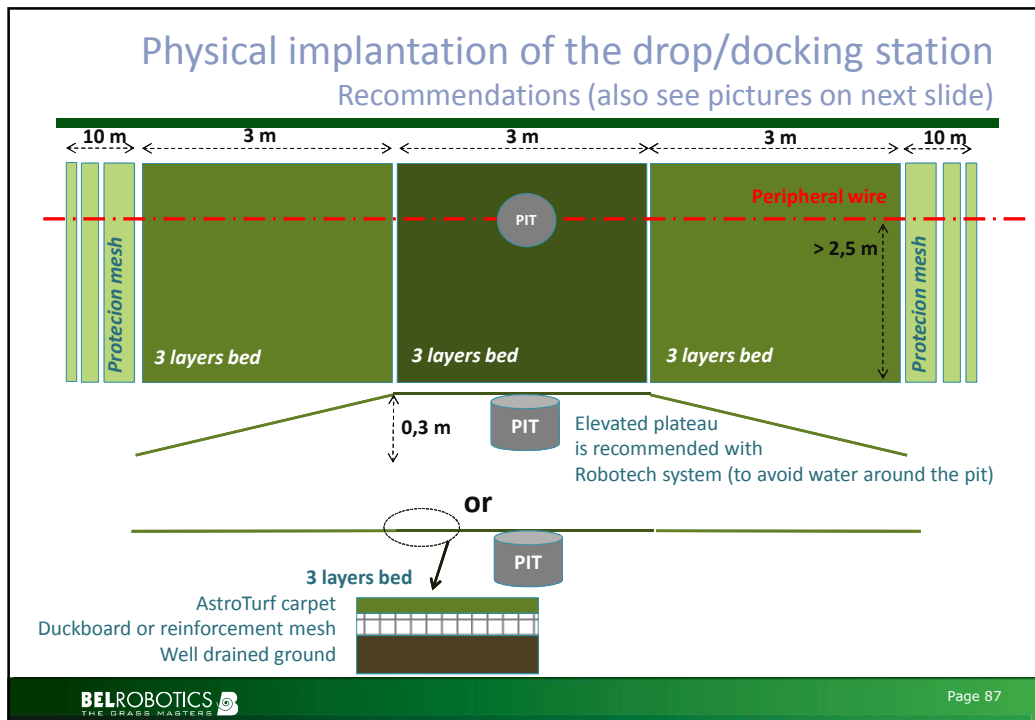
Come and go from/to the back of the driving range

Parameters	Significations	BallPicker		BigMow
		Zone A	Zone B	Zone A
P001	Peripheral wire, length (x10m)	85	40	85
P002	Max dist. On wire leaving station (x10m)	1	1	1
P003	Minimum track border segment	0	0	0
P004	Minimum track border line	200	200	200
P006	Min dist. on wire leaving station (x10m)	0	0	0
P008	Wire signal channel	0	1	0

Options for above configuration

Come and go from/to the back of the driving range

Options	Significations	BallPicker		BigMow
		Zone A	Zone B	Zone A
O000	Multiple robots	V		V
O006	Multiple BallPicker	-		NA
O010	CounterClockWise station seek	-	-	-
O011	Charge on 2 sides	-	-	-
O013	U-Shape return	V	V	V
O016	Multizones	V		-
O017	Enable zone	V	V	V



Reinforcement of the ground at the drop pit location

- The Ballpicker load is between 250 and 300 balls. For a daily collection of 8.000 balls, the Ballpicker comes to drop pit 25 to 30 times a day, following the trackborder and manoeuvring exactly on the same layout near the drop pit.
- Natural grass on well drained ground will be marked with such frequency, whatever you do.

Our recommendation

- Do cover the manoeuvre area around the drop pit with a duckboard covered by artificial turf such as AstroTurf: it can easily be cleaned, and be changed when worn.
- In case of poorly drained ground alongside de track border, consider putting mesh reinforcement (at least in vicinity of the drop pit)

BELROBOTICS THE GRASS MASTERS

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6	Configuration of the balls drop ditch: location and settings
7	Maintenance: daily, periodical, annual
a.	Daily maintenance: inspect and clean
b.	Annual maintenance: grease gearmotors, check/replace joints

BELROBOTICS

THE GRASS MASTERS

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Daily maintenance - Inspect and clean

See Maintenance manual

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THE GRASS MASTERS

Ballpicker Model 2013

Maintenance Guide for End-Users

10 February 2014

About this document

This document is intended for End-Users in charge of daily operation and maintenance of Ballpicker robots on a golf practice. It contains necessary information to carry out the routine maintenance of the Ballpicker.

More specifically, the good practice is to have one person on each golf practice responsible for these operations on Ballpickers and Bigmore robots, who knows the basic operation principles and commands of both machines. The service dealer must have shown to such person all procedures and commands detailed in this document. This "qualified operator" should have a deputy who knows basic instructions to act as appropriate in the case of absence of the qualified operator.

This document is organized as an easy, highly repetitive routine in maximum 17 steps, which need be repeated on a daily basis.

...

BELROBOTICS

THE GRASS MASTERS

10. Clean balls reservoir and trapdoor

- Disconnect two stainless steel cords to access the reservoir



- Remove the trapdoor and clean it to remove grass, mud, branches, debris



- Use you hand to check cleanness of reservoir. Clean it as appropriate. Use a wet sponge if necessary. Make sure that reservoir's corners hidden behind the side disks of collecting drum are perfectly clean. Any ball stuck in accumulated grass, mud or leaves can be damaged and can damage the disks as well.



Ballpicker_End User WMT manual_02.docx

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Ballpicker_End User WMT manual_02.docx

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BELROBOTICS

THE GRASS MASTERS

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Annual maintenance

Control critical mechanical parts and joints

1. Replace the grease in the gear
(Same operation and same grease as for other gear motors on Belrobotics robots)



Annual maintenance

Control critical mechanical parts and joints

2. Check play in the front joints and replace the PVC spacer when necessary



Annual maintenance

Control critical mechanical parts and joints

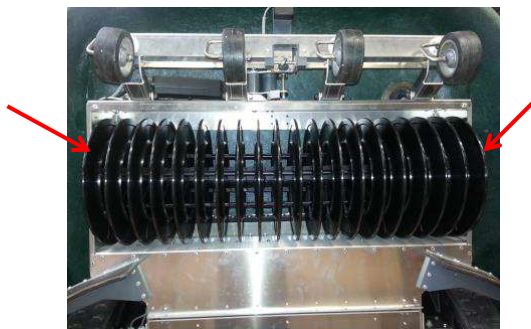
3. Check play in the front train fixation and replace the axle and the plain bearings when necessary



Annual maintenance

Control critical mechanical parts and joints

4. Check disks of the collecting drum:
 - a) If there is play between the bearings and the external disk, replace the external disk right and/or left



Annual maintenance

Control critical mechanical parts and joints

- b) If any of the two opposite bearings on the drum axle is seized, replace both of them



Annual maintenance

Control critical mechanical parts and joints

- c) Checks status of individual disks of the collecting drum

- Disks show radial stripes that prevent balls from spinning between disks. There are 2 such stripes on each disk. Please note that adjacent disks are offset by 90°
- Should such stripes be worn, the disk needs be replaced. This usually occurs after more than 3 years.



Annual maintenance

Control critical mechanical parts and joints

5. Check play in the body switch detector (wears faster on the Ballpicker) and replace the stainless steel axle and both plastic terminals



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9	<i>References</i>

Automated golf driving ranges

Some references in Belgium and Netherlands (1/3)

#	Golf/Practice	Configuration	Transfer system
B	7 Fontaines	1 BM, 2 BP	Down in a basket. Manual transfer
B	Bercuit	1 BM, 1 BP	Hydraulic over 30 m > washer > dispenser
B	Brussels/Forest	1 BM, 1 BP	Down in a basket. Manual transfer
B	Houthalen	1 BM, 1 BP	Hydraulic over 30 m > dispenser
B	3 Eiken	1 BM, 1 BP	Down in a basket. Manual transfer
B	Naxhelet	2 BM, 2 BP	Hydraulic over 50 m > washer > dispenser
B	Wijnvelden	1 BM, 1 BP	Direct transfer > washer > dispenser
NL	Eindhoven	1 BM, 1 BP	Direct transfer > washer > dispenser
NL	Amstelveen	1 BM, 1 BP	Direct transfer > washer > dispenser
NL	'Hertogenbosch	1 BM, 1 BP	Direct transfer > washer > dispenser
NL	Utrecht	1 BM, 1 BP	Direct transfer > washer > dispenser

Automated golf driving ranges

Some references in United Kingdom and Ireland (2/3)

#	Golf/Practice	Configuration	Transfer system
UK	Tonbridge (Kent)	1 BM, 1 BP	Pneumatic (Robotech) > dispenser
UK	Four Ashes (Midlands)	1 BM, 1 BP	Pneumatic (Robotech) > dispenser
UK	Keele (Midlands)	1 BM, 1 BP	Pneumatic (Robotech) > dispenser
UK	Elsenham (NE London)	1 BM, 1 BP	Pneumatic (Robotech) > dispenser
UK	Sandown (SW London)	1 BM, 1 BP	Pneumatic (Robotech) > dispenser
UK	> 15 new sites in 2014	1 BM, 1-3 BP	Pneumatic (Robotech) > dispenser
IRL	> 2 new sites in 2014	1 BM, 1-3 BP	Pneumatic (Robotech) > dispenser

Automated golf driving ranges

Some references elsewhere in Europe (3/3)

#	Golf/Practice	Configuration	Transfer system
F	Lille (NW)	1 BM, 1 BP	Down in a basket. Manual transfer
F	Niozelles (SE)	1 BM, 1 BP	Hydraulic over 30 m > dispenser
I	Panorama, Varese (NW)	1 BM, 1 BP	Pneumatic (Robotech) > dispenser
I	Tartaruga, Treviso (NE)	2 BM, 1 BP	Direct transfer > dispenser (custom)
I	Bergamo, Indoor pitching	1 BP (°)	Pneumatic (custom) > dispenser
E	? (NW)	1 BM, 1 BP	Down in a basket. Manual transfer
SE	Angsö	1 BM, 1 BP	Direct transfer > washer > dispenser
SE	Äkersberga	1 BM, 1 BP	Direct transfer > washer > dispenser

(°) See next slide

Example of indoor practice Golf pitching practice, Bergamo, Italy



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