# Rectangular Coordinates: XYZ vs NEZ

Excavators and Concrete Contractors have discovered the ease and accuracy of using a Total Station in doing layout. The instrument does not usually present any problem to the user while leveling, using the optical or laser plumb, reading horizontal and vertical angles, or taking distance shots with the EDM (Electronic Distance Meter). However, the on-board computer which allows uploading and downloading of coordinate points does befuddle some new users. After the coordinate points are loaded into a file within the on-board computer (termed data storage), built-in routines make the Total Station easy to use. After choosing the LAYOUT function in a Total Station, the gun prompts the user to choose a file (more than one job can be stored in the memory). Once the job is selected, the gun asks what point is being OCCUPIED. From a list of points, the user specifies over which point number the instrument has been set. The gun then prompts to choose a BACKSIGHT POINT. Another point in the list is chosen and the gun is aimed at that point. After that step, the user is asked to pick a point to layout. Once again, a point is picked from the list. The LCD display then instructs the user to turn the gun until a certain angle is reached, which is viewed on the LCD display. The gun is horizontally locked at that reading. A rodperson with a prism pole and prism then sets out along that line. At anytime, the user can take a shot at the prism and a distance will be returned indicating how far (plus or minus) the target is from the desired layout point. Total Stations have a TRACKING function which will constantly take shots at the prism to give a stream of readings as the rodperson is moving away from the Total Station. Generally, the most difficult part of the whole process is obtaining the desired coordinate points in a useable format. Two coordinate systems are used and are explained below to facilitate getting the correct information to load into the Total Station.

Cartesian Coordinates: X Y Z

Most of us have been exposed to graphing using X & Y axis on a graph. If not, the principle of locating a point is the same as playing Bingo or Battleship. To locate Point #1 which has an X value of 40 and a Y value of 20, one would find where the x=40 and Y=20 line intersect.

The example on the right shows Point #1 located on a flat graph. If Point #1 was hovering over the paper, it would have a Z value indicating its elevation. Let's assume the point has a value of Z=10. Coordinates on a jobsite will often have all three values of X,Y, Z. Each Point would also be given a Point Number and often a Description or Code. So if Point #1 is a corner of a building, it could be described in an XYZ format as:

### 1,40,20,10,crn

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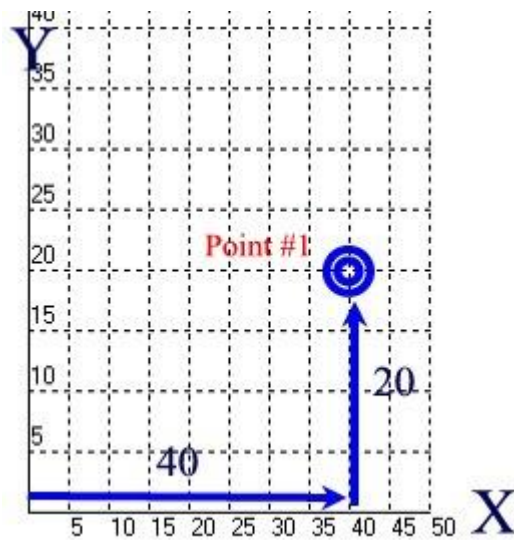
Northings & Eastings: N E Z

Many of the CAD programs (Computer Aided Design) use the X,Y,Z coordinate system for drafting. But Surveyors have come up with their own system in which they rename the Y axis as North (though that axis does not really have to point North), the X axis as East, but keep the elevation designation as Z. So a Surveyor would plot Point #1 as follows:

Point #1 would be described in a NEZ format as:

1,20,40,10,crn

Obviously, Point #1 will be located in the same place as above.

Total Stations can be set up to accept either XYZ or NEZ formats. The user **MUST** be aware of which format they are receiving when seeking coordinate information. Usually, a user can request from the Engineer, Surveyor, or Design Firm how they wish to receive the information: either as "point number, X,Y,Z,description" or "point number, N,E,Z,description"…sometime abbreviated as P,X,Y,Z,D or P,N,E,Z,D
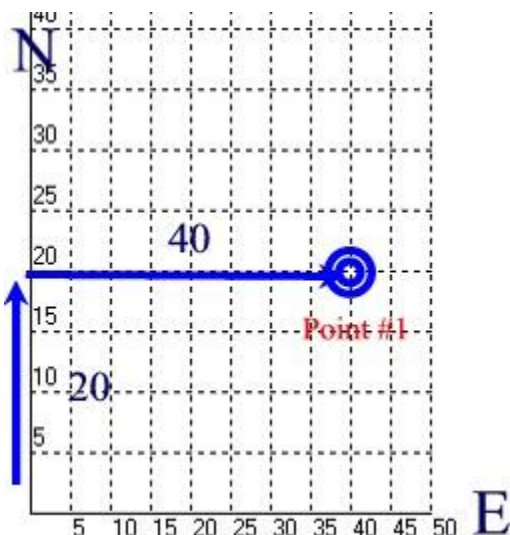
The appearance of a Coordinate File:

The following drawing is of a building with various points (#6 to #23) around the perimeter. Point #1 and #2 are Benchmarks set by the surveyor. To layout the building, the Total Station could be set up over Point #1 or Point #2, using the other Point as the BACKSIGHT. Then, any of the Point numbers could be chosen from a list and the LCD would instruct what angle to turn the gun and how far back to go to stake out the desired point.
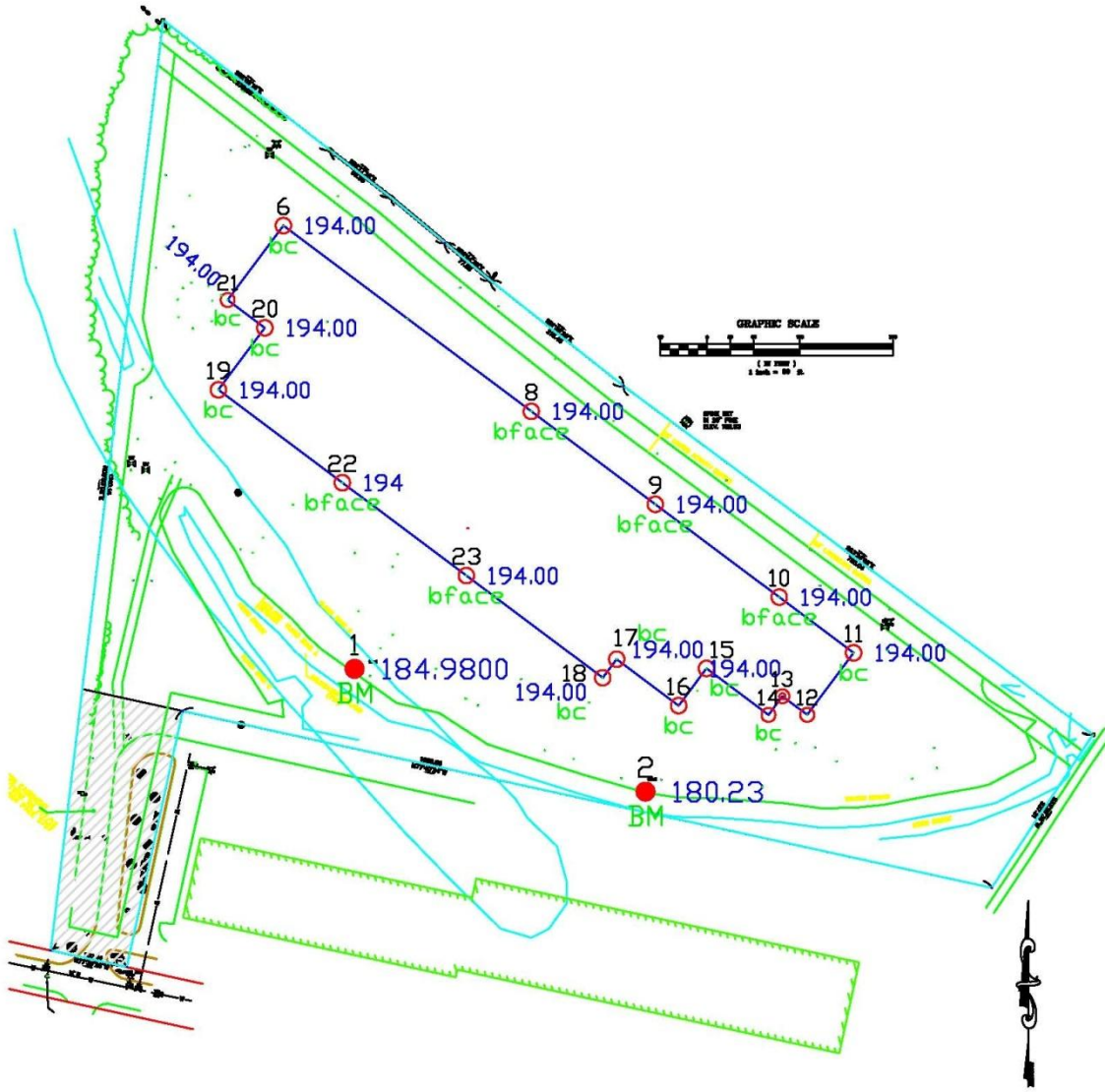
The list of points is as follows:

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
1	4013.632	4386.496	184.980	BM
2	3855.198	4762.072	180.230	BM
3	4461.772	4350.852	194.314	BM
6	4585.957	4294.613	194.000	bc
7	4466.020	4454.661	194.000	bface
8	4346.083	4614.708	194.000	bface
9	4226.147	4774.756	194.000	bface
10	4106.210	4934.803	194.000	bface
11	4034.248	5030.832	194.000	bc
12	3954.224	4970.863	194.000	bc
13	3978.211	4938.854	194.000	bc
14	3954.204	4920.863	194.000	bc
15	4014.173	4840.839	194.000	bc
16	3966.158	4804.858	194.000	bc
17	4026.127	4724.835	194.000	bc
18	4002.120	4706.844	194.000	bc
19	4373.923	4210.697	194.000	bc
20	4453.947	4270.665	194.000	bc
21	4489.928	4222.651	194.000	bc
22	4253.987	4370.745	194.000	bface
23	4134.050	4530.792	194.000	bface

If the data is sent to a user as an attachment to an email, opening the attached file would produce something resembling the following:

1,4013.63187,4386.49622,184.98000,BM
2,3855.19767,4762.07175,180.23000,BM
3,4461.77249,4350.85211,194.31442,BM
6,4585.95663,4294.61327,194.00000,bc
7,4466.01993,4454.66073,194.00000,bface
8,4346.08323,4614.70818,194.00000,bface
9,4226.14653,4774.75563,194.00000,bface
10,4106.20982,4934.80309,194.00000,bface
11,4034.24780,5030.83156,194.00000,bc
12,3954.22408,4970.86321,194.00000,bc
13,3978.21142,4938.85372,194.00000,bc
14,3954.20430,4920.86321,194.00000,bc
15,4014.17265,4840.83948,194.00000,bc
16,3966.15841,4804.85847,194.00000,bc
17,4026.12676,4724.83475,194.00000,bc
18,4002.11965,4706.84424,194.00000,bc
19,4373.92342,4210.69713,194.00000,bc
20,4453.94715,4270.66549,194.00000,bc
21,4489.92816,4222.65125,194.00000,bc
22,4253.98672,4370.74459,194.00000,bface
23,4134.05002,4530.79204,194.00000,bface

Most Total Station vendors provide free software to transfer coordinates back and forth from a computer. Some settings must be synchronized between the Total Station and the computer when first installing. But after the initial setup, users generally find the process problem-free.