

(Informal) Robotics Kits Comparison

Written by:

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I choose the following kits because:

- Do not need soldering
- Must have a programmable controller
- Offer true programming language capability.
- Offer technology curriculum and instructions
- Most used in competition, and under \$500

There may be many other kits out there which may fit in the criteria, but with limited resources, we have chosen some commonly used ones:

- Machine Science (machinescience.com)
- NXT (legoeducation.com)
- IntelliBrain2 (ridgesoft.com)
- C-Stamp (c-stamp.com)
- VEX (vexlabs.com)

Disclaimer: Content reflects only facts to my best knowledge via internet research, data received from experienced individuals, some with my own experience, and Q&A from manufacturers. Nothing on this document shall be construed as official views from the manufacturers. Storming Robots shall not be liable for any errors or omissions contained in this document.

Summary	Machine Science	NXT	IntelliBrain 2	C-Stamp – CS710001	VEX -Robotics Design System
Manufacturer	Machine Science/Microchip	LEGO	Ridge Soft	A-WIT	VEX labs
Chassis	(Basic + Sensor Expansion kit) Modular, by Machine Sci	LEGO Technic and other parts	Modular metal and plastic, supplied by ridgesoft	Modular light weight high strength acrylic by A-WIT	Modular metal, by VEX labs
Mounting	by Machine Sci	LEGO Technic	Metal studs, supplied by Ridgesoft	by A-WIT	VEX mounts (only specific to VEX)
Motors	2 DC motors	3 Servo motors	2 DC motors	2 servo motors (with position sensing disabled)	3 DC. 1 Servo
Encoder (for position sensing)	No. Available only via 3 rd party vendor. Precision: unknown	Embedded in motors. Precision: 1degree	Nubotics WheelWatcher shaft encoder. Precision: unknown	Available (can use the infrared Contrast Sensor. Must align properly with the motor.) Precision: 6 degrees	2 Optional Shafts. Precision: N/A
In Box Sensors	2 IR Sensor*	2Touch, 1 Sound Level, 2 Light, 1 Ultrasonic Range, 2 motors with integral servo capability	1 IR range, 1 line tracking, 1 ranging	1 IR sensor, 2 Limit Switches, 1 light sensor	2 Bumper Switch 2 limit switch sensors 1 DC motor 1 Servo motor
Add On Sensors	Add ons available, but not directly from M.S., but from third party vendors. Any device that generates an analog 5V or quadrature 5V signal can be used	Third parties from http://www.mindsensors.com/ & www.hitechnic.com/	From IntelliBrain www.ridgesoft.com	From A-WIT. http://www.c-stamp.com , Line tracking, Ultrasonic Ranging, Shaft Encoders, and third parties with analog or 5V digital interface	Light Sensor, Line tracking, Ultrasonic Ranging, Shaft Encoders

Programming Language	C via MPLAB (Ansi-C complete)	NXT software powered by LabView. You can also find an array of languages available, such as Robolab, RobotC, etc. www.teamhassenplug.org/NXT/NXTSoftware.html	Java via RoboJDE.	C via MPLAB IDE (v7.22 and up)	None with kit. May purchase EasyC or MPLAB at additional cost.
Number of Programs Stored	Available memory varies by controller. (4KB program memory for PIC16F877, the base controller)	Varies by program length. 256KB FLASH memory available	Varies by program length. 128K FLASH memory available	Varies by program length. 32K FLASH memory available	Available memory varies by controller.
Open Source Dev	Yes	Yes	NO	NO	Yes
Processor	Microchip PIC16 and PIC 18 series.	32-bit ARM7.	Atmel ATmega128	Microchip PIC 18 series.	Microchip PIC18 series
Expansion Boards (if any)	other parts adaptable to the processor	None	expansion available by I2C (Inter-Integrated Circuit)	Expansion sold by A-WIT.	none sold by VEX labs. There might be programming workarounds for this.
Wireless?	No	Bluetooth	InfraRed	InfraRed	IR Kit Available.
I/O Details	8 ADC inputs, 12+ digital inputs/outputs, I2C port, USART	4 Inputs, 3 Outputs. Servo motors connect via outputs and provide position feedback through output ports	8 Servo outputs 7ADC (analog / digital) inputs, 13 digital inputs, 2 DC motor ports, 2 RS-232 Serial Ports	41 digital I/O 2 Dedicated RS-232 Serial. 12 ADC, 2 DAC, 3-wire SPI™ Master and Slave, I²C Master and Slave, Parallel Slave Port, and 2 Analog Comparators.	8 Motor Outputs, 16 ports (analog in, digital I/O), 6 interrupt ports available.
Power Source	4 AA batteries	6 AA Batteries	6 AA Batteries	one 9V Battery	7.2V Rechargeable Battery pack, VEX proprietary.
No load motor characteristics	n/a	170rpm	n/a	60 rpm	n/a
Stalled torque (to estimate the maximum weight***	n/a	50N.cm (≈ 10lbs) Visit http://www.philohome.com/motors/motorcomp.htm for reading its excellent data.	34N.cm (≈ 7lbs)	33N.cm (≈ 7lbs)	73N.cm (≈ 14lbs)
Display (if any)	LCD available, other parts adaptable to the processor	2" square LCD	2 line LCD display, 16 characters per line	Not included, but available by A-WIT. Ports could be used for display.	none standard. Ports could be used for display
Pneumatic components	No	Available at legoeducation.com	No	No	Available at vexlabs.com .
Device to PC Interface	Both RS-232 and USB	USB	RS-232 serial only	Both RS-232 and USB	RS-232 only
Host PC Requirements	Typical Win XP System Via RS-232 or USB port.	Typical Win XP system, or Mac OSX v10.3.9 /10.4. via USB or bluetooth	Typical Win XP system 128 MB RAM Via RS-232	Typical Win XP system 128 MB RAM Via RS-232 Serial Port or USB port..	Typical Win XP system 256 MB RAM Via RS-232 Serial Port.

Processor

Processor	Machine Science	NXT	IntelliBrain 2	C-Stamp – CS710001	VEX - Robotics Design System
	Microchip PIC16 and PIC 18 series.	32-bit ARM7.	Atmel ATmega128	Microchip PIC18 series	Microchip PIC18 series
8bit vs. 32 bit.	8-bit Instruction set	32-bit RISC	32-bit RISC	8-bit instruction set	8-bit instruction set
Speed	10MIPS (40 MHz)	133MHz	100MHz	~10MIPS (40MHZ)	10MIPS
Ram	32K	64K	132K	2K	n/a
Flash	4K	256K	128K	32K	32K

To Solder or Not to Solder:

As we all know soldering can be extremely frustrating, and time consuming. We'll then ask whether it will be stable enough if not soldering components. As far as the components not being soldered, most boards have some pre-soldered components, such as LEDs and switches. For example, the machine science set use components with JST connectors. According to the manufacturers, they are far more than adequate for an educational setting.

Best Bank for your Buck:

When I choose a set, I base on the following criteria:

- Ease of mechanical building. Prefer no soldering.
- True Programming interface, such as C-compliance or C-like, maybe Java-based. If it is gui-interface, I just stick with Robolab, as it highly resembles the industrial engineering software LabView.
- Expandability
- Capability for doing more precious math calculation, such as floating points calculation.
- Parts Reusability.
- Capability of multi-tasking.
- Cost me the least!

Best Bank for Your Buck Criteria for Storming Robots:

CRITERIA	MACHINE SCIENCE	NXT	INTELLIBRAIN 2	C-STAMP – CS710001	VEX - ROBOTICS DESIGN SYSTEM
Cost (# of projects stated above per \$)	Unknown. Suspected to be comparable to C-Stamp. However, if you factor in the time you spend on hunting down the right parts, it will not as desirable.	Good price.	Most expensive.	Best	Most expensive.
Instruction	Machine Science offers great online FREE instructions, but not so much a comprehensive curriculum.	You will purchase curriculum from CMU-Robotics Engineering Center. It covers fundamentals activities for middle to high school levels. We add in a lot more activities in order to provide enough challenge meeting our roboclub need.	<i>It comes with a good instruction booklet and curriculum focusing on using the set.</i>	<i>It comes with a good instruction booklet and curriculum focusing on using the set.</i>	<i>It comes with a good instruction booklet and curriculum focusing on using the set.</i>
East of building	Medium	Easy	Medium	Medium	Medium
Programming Concurrency	Yes	Yes	Yes	Yes	No

CRITERIA	MACHINE SCIENCE	NXT	INTELLIBRAIN 2	C-STAMP – CS710001	VEX - ROBOTICS DESIGN SYSTEM
Programming interface	No fancy IDE. But one nice thing is that the compiler is supposed to be fully Ansi-C compliant.	There is a large array of programming software and IDE available, including Gui-based, and text-based. For example, Robolab or Labview: suitable for kids (from 4 th grade) to sophisticated robotics hobbyist. Then, you will find others like Robot-C or NXC. They are not fully Ansi-C compliant though. Then, you may use the free MS Robotics Visual Studio.	Good IDE. Proprietary Java-based programming software. This may be a good choice for high school kids as the Advanced Placement Computer Science is also Java based.	No fancy IDE. <i>But one nice thing is that the compiler is supposed to be fully Ansi-C compliant.</i>	Good IDE. C-based. But not fully Ansi-C compliant.
Expandability	High	Low	High	Very high	High
Explore Electronic	Yes	No	Yes	Yes	No
Parts Reusability	Medium	Very High	Medium	Medium	Medium
Grade Levels	Junior High School +	Elementary School to High School.	Junior High +	Junior High +	Junior High +
Accessibility of parts	Poor. Machine Science base set does not come with gears. You may find most sensors and other electronic components from www.acroname.com , and others. If you wish to do anything more elaborate like most of the projects above, you will need to purchase most components from 3 rd party vendors. If you like shopping around for electronic components, you may find this enjoyable and give you much flexibility. Besides, you will find good support from machine science. However, if you do not have the luxury of time to look around or the sufficient electronic background, you may find it quite frustrating.	Good. Can buy most right off the LegoEducation and BrickLInk.com website. You should be able to find most 3 rd party hardware from hitechnic.com, or mindsensors.com. When it comes to rebuild-ability, you cannot beat this.	Good. The basic package is packed with goodies. It also comes with a very good instructions focusing on using the set. Can buy most right off the RidgeSoft website.	Unknown.	<i>You can purchase most parts for the projects such as those listed above right off the manufacturer's website. Pretty convenient.</i>

Floating point	Offer floating point support. Unknown in its precision.	Offer floating point support. Can achieve satisfactory precision.	Offer floating point support. Unknown in its precision.	Offer floating point support. Unknown in its precision.	Offer floating point support. Unknown in its precision.
Competition Opportunity	Most	Most	Most, except FIRST	Most, except FIRST	Most Note: FIRST FVC will change its platform in 2009 to NXT-like platform.
	Check out the Robotics Education Matrix at http://robotics.nasa.gov/edu/matrix.php .				

Best Bank for the Buck:

From the list above, NXT has come out as the obvious choice, unless you want to play with industrial level of machines. If your child is interested in mechanical engineering in college, NXT definitely is lacking because it still can deliver the basic mechanical concepts from gear system, calculating torque vs speed, to PID controlling.

Do not underestimate the educational value of NXT. A lot of our middle school students are engaged in pretty hefty programming, such as doing localization, learning the PID concept, event-driven, inter-robots communication, synchronization among tasks, etc. A couple of our older students (now they are now using VEX), told me they actually have done a lot more intricate programming with us when they use Mindstorms. This does not mean VEX does not offer enough challenge. It simply means what you can get just as much challenge, if not more, from NXT/RCX, even from LEGO. If taught with proper expertise, it can truly give kids, even high schoolers, the exposure to true robotics experience.

Important: I'm **not** trying to sell Mindstorms here. We have more than 90 students. We need to invest on something which is sustainable in terms cost and best fit for students for pre-college students.

Approximate Cost for some typical projects (2008)

Projects	Machine Sci.	NXT	IntelliBrain 2	C-Stamp	VEX
Base Kit	\$196***	\$250	\$440	\$150	\$300
With Programming Software	\$196	\$350 (WITH ROBO LAB) \$280 (WITH ROBOTC) \$250 (WITH NXC)	\$440	\$150	\$400 (\$100 + \$300)
Position sensing for motion (with encoders)	----	\$250 +	\$440	\$155	\$420
Line Following with a single light or IR sensor	\$220+	\$250+	\$440	\$150	\$420
Extreme Line following Racing with 2 light or IR sensors:	\$220+	\$250 +	\$440	\$160	\$440
Simple Obstacle course using touch sensor	\$220+ Via 3rd party	\$250+	\$440	\$180	\$400
Obstacle course with one range sensor:	\$230+ via 3rd party	\$250 +	\$440	\$172+	\$430
Localization with a compass and range sensor	\$285+ via 3rd party	\$300+ via 3rd party	----	\$215+	----
Simple GeoCaching with GPS :	\$230+ via 3rd party	----- Must be via Bluetooth	----	----	----
3D motion control with Accelerometer	----	\$300+ via 3rd party	----	----	----
Add in a simple end effector like a claw (need 3rd motor)	\$230+	\$250 +	\$440 +	\$163 +	\$400 +
A separate Remote Controller	----	----	----	----	\$400
For all the projects above + software	----	\$440+	\$450+	\$228+	\$490+
Extra sensors & motors					
Servo Motor	\$97	\$18	\$13	\$13	\$20
Light Sensor	\$38	\$17	\$20	\$5	\$20
Touch/bumper Sensor		\$17		\$6	\$13
Limit Switch	\$14+	----		\$6	\$13
Encoder (for motor feedback)	\$27 Via 3rd party	None (embedded in motor).	\$27 Via 3rd party	\$5	\$20
Compass Sensor	\$59 via 3rd party	\$47 Via 3rd party	\$59 Via 3rd party		
Range Sensor	\$29.50 Via 3rd party.	\$32 Fr. LEGO	\$39.	\$30	\$30
Image Sensor (Camera)	\$\$\$\$ via 3rd party	\$98 Via 3rd party	\$\$\$\$ Via 3rd party	\$\$\$ FR. C-stamp	None from package. Unknown otherwise.

Note:

- ✚ All numbers take approximation, e.g. 344 will be listed as 350, 249.99 to 250, etc.
- ✚ ----- = information not available or not found yet. It does not mean you cannot find other 3rd party electronic components.