energies

MDPI

Appendix A1. Design of the Survey and parameters analyzed. (Users and No users)

Tools	Object	General Criteria of *"items"* SPSS data Analysis	Questions
Bibliographic	-	Detection of the main problems in order to help design the survey.	Background
Survey Users without training on BPSTs: 121 recent graduate architects	Description of the respondents	Profession (i1); other (i2); years of professional experience (i3); projects accomplished (i4); architectural practice (i5); employers in their company (i6); country of origin (i7).	Q1-Q5
	Energy simulation	Starting year of BPSTs utilization (i8); BPSTs evolution (i9); definition (i10); own definition of energy simulation (i11); *, objective of the energy simulation (i12); another possible objective* (i13).	Q6-Q9
	Previous knowledge	Parameters considered in a BPST (i14); building geometry (i15); model simplification (i16); type of user of BPSTs (i17); architects' level of knowledge (i18); BPSTs used (i19); other BPSTs* (i20).	Q10-Q15
	Arch. Design	Stage of the design process (i21-i23); skills (i24-i26).	Q16
	Training	University training (i27); energy-assessment teaching level (i28); BPSTs use promotion in the university (i29); level of importance of BPSTs training in the university (i30); promotion in the university (i31); suggestion to enhance the interest in BPSTs* (i32).	Q17-Q21
	Reliability	Trial and error process (i33); outcomes validation (i34); , BPSTs tools at work (i35); users use BPSTs (i36); non-used BPSTs indicating the reasons (i37); other reasons* (i38).	Q22-Q26
	Application of BPSTs	Type of projects (i39); the decision making process in order to integrate BPSTs (i40); proposals*(i41); best stage to use energy simulation(i42); BPSTs and the design stage(i43); simulation software helping create geometry (i44).	Q27-Q31
	Acquisition	Fields where BPSTs can be useful(i45); importance of simulation before building construction(i46); economic cost(i47); design process(i48); architect's skill and experience (i49).	Q32-Q36

	Relation with architects	Quantitative simulation software (i50); optimum building design (i51); aspects previously ignored (i52); barriers creating constructions (i53); optimum-shape design(i54); design necessities (i55); integrate in the design (i56); confidence (i57); knowledge (i58); reliability (i59); collaborate (i60); control of parameters (i61).	Q37-Q48
	Interest	Interest (i62); design assistance (i63); learning (i64); BPSTs intended for professionals (V65); nearly zero energy buildings (i66); limiting the architect's creativity (i67).	Q49-Q54
	Future	Energy simulation interest (i68); BPSTs implemented architecure offices (i69); Guides to show equivalences passive strategies designed (i70) ; advantages and disadvantages facilitate BPSTs (i71); opinion or suggestions (i72).	Q55-Q59

Appendix A2. Design of the Survey and parameters analyzed (Users)

Tools	General Criteria of *"items"* SPSS data Analysis	Questions
Survey Users with training on BPSTs: 50 recent graduate architects	Courses attended (i73); place (i74)*; self-taught (i75); specific training, software-manuals quality, satisfaction with BPSTs use, importance, BPSTs to develop their projects, adequation for architects (i82), training* (i83).	Q60-Q67
	Parameters influence, Interface, barriers	
	Simple interface design (i84); Data export with other software (Autocad, Sketchup…) (i85); Cost (i86); Simulation time (i87); 3D modelling included in the same software (i88); Easy data entry (V89); Position in the market (i90); Adaptation to the national regulation (i91); Easy interpretation of the results (i92); Auxiliary use of additional software (i93); Easy training (i94).	Q68
	Which of the next actions do you think is more important?	Q69
	Easy output interpretation (i96); Flexible use (i97); Graphical representation of the results (i98); Adaptation to the national regulation (i99); Easy training (i100);	Q70
	Software evolution (i101); Complexity of use (i102); Learning curve (i103); Software tools not integrated in CAD tools (i104); High economic cost (i105); Poor interface (i106); Interpretation of outcomes (i107); Simple tools which do not provide the necessary information (i108).	Q71

	Data input and output, navigation and control (i109); Learning curve (i110); Documentation (i111); online help (i112); Software tools not integrated in CAD tools (i113); Tables for consulting (i114); Use default values and data input templates (i115); Database where construction materials are easily found Base (i116); Graphic representation of the design parameters (easy to understand by architects) 3D (i117); Visualization and design strategies Templates for the user relating to HVAC (i118); Error checking in order to ensure that the models used are correct (i119); GLOBAL ASSESSMENT CRITERION (i120);	Q72
	Qualitative and quantitative knowledge about the design decisions (i121); Templated creation (i122); Meeting the codes and rating systems (i123); Find objective responses to design question. (i124); Life-cycle assessments (i125); Economic aspects (i126); Definition of the most important parameters in the design stage (i127); Approach based on comparative design (i128); Generation of design alternatives(i129); Materials selection during the design stage (i130); Decision making process (i131); Low cost buildings (i132); Orientation about passive design (i133); Big components library (façades, roofs, etc...) (i134); GLOBAL ASSESSMENT CRITERION (i135).	Q73
	Validity, quality and resolution (i136); Accuracy (i137); Ability to simulate elements with sufficient detail (i138); Optimization of the building envelope (i139); Consideration of natural ventilation (i140); Information of the cost of energy reduction measures (i141); GLOBAL ASSESSMENT CRITERION (i142).	Q74
	It transfers information from one software to another without losing information and in a comfortable way (i143); It enables to manage and communicate construction data between different collaborators (i144); It alllows modeling of organic volumen and non-cubic zones (i145); It allows the input of multiple modeling programs (i146); GLOBAL ASSESSMENT CRITERION (i147).	Q75
	Alternation of the simulation process with the design process (i148); Multidisciplinary interfaces (i149); GLOBAL ASSESSMENT CRITERION(i150).	Q76
	Improvements, Opinions of users* (i151)	Q77
	All the respondents (i152)	Q78

*Open questions ; Q (Number of Question)

ENERGY SIMULATION OF BUILDINGS

Aim of the survey: opinion on the energy simulation of buildings.
Building Performance Simulation Tools (BPSTs).
Estimated time: 10min. 60 questions.
Thank you.

ARIE Research Group. Universidad CEU San Pablo. Madrid (Spain)

1. Profession

Mark one only answer.

- ◯ Architect
- ◯ Architect and Architecture professor
- ◯ Student
- ◯ Other

1.a) If "other" is selected, say which one:

_____

2.If you are an architect, how many years of professional experience do you have?

Mark one only answer.

- ◯ Less than 5 years
- ◯ 5-10 years
- ◯ 10-20 years
- ◯ More than 20 years

3. Projects in which you are involved

More than one answer may be selected.

- ☐ Residential
- ☐ Hotel
- ☐ Education
- ☐ Health
- ☐ Office
- ☐ Renovation
- ☐ Commercial
- ☐ Industrial
- ☐ Other

4. Among the following categories, identify the one which best fits your architecture practice

More than one answer may be selected.

- [ ] Traditional with variety in projects
- [ ] Traditional with building renovation or refurbishment
- [ ] Design and construction
- [ ] Construction management
- [ ] Other

5. Nº of employers in your company / office / workplace

Mark one only answer.

- ◯ Less than 3
- ◯ 3-10
- ◯ 11-50
- ◯ More than 50
- ◯ Nobody

***5.*a) Country where you work**

_____

6. From what year do you think there is a general interest in energy simulation?

Mark one only answer.

- ◯ Prior to 1960
- ◯ 1960-70
- ◯ 1970-80
- ◯ From 1990
- ◯ No answer

7. As per your viewpoint BPSTs' evolution from 1997 to 2010 has been...

Mark one only answer.

- ◯ Doubled
- ◯ Unchanged
- ◯ Quadrupled
- ◯ No answer

8. How would you define energy simulation?

More than one answer may be selected.

- [ ] Calculation tool which serves to test, prevent, and optimize buildings
- [ ] Tool used to design a sustainable building (new or refurbished)
- [ ] Tool used to achieve energy savings and the efficient functioning of buildings
- [ ] No answer

8.a) Please, write your own definition

9. What do you think is the objective of energy simulation?

More than one answer may be selected.

- [ ] It enables us to analyze both the quality and the environmental demand of buildings
- [ ] It enables us to develop a proper calculation in order to foresee the future building performance
- [ ] It enables us to detect efficient methods to reduce the building energy consumption
- [ ] It helps us to decide the best design strategy at the first stage of the architectural project
- [ ] No answer

9.a) Please, write another possible objective

10. Which parameters do you think are considered in a BPST?

More than one answer may be selected.

- [ ] Thermal zones
- [ ] Building type
- [ ] Openings (glasses and skylights)
- [ ] Outdoor shadow
- [ ] Indoor heat gain (occupation, equipment, lighting...)
- [ ] HVAC systems (heat, ventilation and air-conditioning)
- [ ] Climate
- [ ] Environment
- [ ] None of the above
- [ ] No answer

11. In order to simulate a building, which of the following statements do you think is/are correct?

More than one answer may be selected.

- [ ] The geometry definition must be as detailed as possible
- [ ] Form abstraction and maximum simplification of the geometry
- [ ] I do not think that buildings could be correctly simulated
- [ ] No answer

12. Do you think that building geometry should be simplified for in order to carry out the simulations?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

13. Which type of user do you think works with BPSTs?

More than one answer may be selected.

- ☐ Architects
- ☐ Engineers
- ☐ Energy consultants
- ☐ Researchers
- ☐ No answer

4. What is the architects' level of knowledge of BPSTs?

Mark one only answer.

- ◯ Good
- ◯ Sufficient
- ◯ Insufficient
- ◯ No answer

15. Which of the following BPSTs have you used?

More than one answer may be selected.

- ☐ Ecotect
- ☐ SketchUp
- ☐ Design Builder
- ☐ Open Studio plug-in
- ☐ Energy Plus
- ☐ None

15. a) If you have used other BPSTs, please name them

_____

_____

_____

_____

_____

16.a) In which stage of the design process do you use the following software?

More than one answer may be selected.

	Conceptual stage	Initial design	Detailed design	Construction stage	No use
CAD tools (Rhinoceros,Revit,Autocad,3DS Max...)	☐	☐	☐	☐	☐
Visualization tools(V-Ray,Atlantis...)	☐	☐	☐	☐	☐
Simulation tools (Ecotect,DesignBuilder,Trnsys,Energy...)	☐	☐	☐	☐	☐

16.b) Which is your skill in the use of the following software?

More than one answer may be selected.

	Far advanced	Advanced	Normal	Low	Very low
CAD tools(Rhinoceros,Revit,Autocad,3DS Max...)	☐	☐	☐	☐	☐
Visualization tools (V-Ray,Atlantis...)	☐	☐	☐	☐	☐
Simulation tools (Ecotect,DesignBuilder,Trnsys,Energy...)	☐	☐	☐	☐	☐

17. In your university, specifically in Architecture studies, is there a use of BPSTs ?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

18. **What do you think is the energy-assessment teaching level in the university?**

Mark one only answer.

	1	2	3	4	5	
Little	◯	◯	◯	◯	◯	Much

19. To what extent do you think your university promotes the interest in energy simulation?

Mark one only answer.

	1	2	3	4	5	
Little	◯	◯	◯	◯	◯	Much

20. What do you think is the level of significance of BPSTs training in the university?

Mark one only answer.

	1	2	3	4	5	
Little	◯	◯	◯	◯	◯	Much

21. How do you think the use of BPSTs can be promoted in your university?

More than one answer may be selected.

- [ ] Lectures and workshops with experts or stakeholders in the building simulation field
- [ ] Use of BPSTs in undergraduate courses or master thesis projects
- [ ] Through courses in Official School of Architects
- [ ] Courses in master's degree or doctoral degree

21.a) Please, write a suggestion to enhance the general interest in BPSTs

_____

_____

_____

_____

_____

22. Do you think that BPSTs learning should be carried out by trial and error process?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

23. Do you think that the validation of outcomes (through comparison with real results) is necessary?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

24. Do you use BPSTs tools at work?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Occasionally

25. How many people do you know who use BPSTs tools?

Mark one only answer.

- ◯ Less than 5
- ◯ 5-20
- ◯ More than 20
- ◯ None

26. If you have not used BPSTs, indicate the reasons

More than one answer may be selected.

- [ ] I do not need them
- [ ] I do not have enough motivation
- [ ] Architects are not responssible of these issues
- [ ] Unknown tools
- [ ] Insufficient knowledge in the field
- [ ] High economic cost
- [ ] Hard to learn

26. a) Other reasons

27. According to your opinion, in which type of projects do your think BPSTs are necessary?

More than one answer may be selected.

- [ ] Simple projects
- [ ] Complex projects
- [ ] Always
- [ ] No answer

28. How would you manage the decision making for the integration of BPSTs in the case of small projects?

More than one answer may be selected.

- [ ] I would do it myself
- [ ] Consulting another architect
- [ ] Involving an external consultant (specialist)
- [ ] Involving someone (other profession)
- [ ] No answer

28.a) Please, indicate a proposal:

29. Which do you think is the best stage to use energy simulation?

More than one answer may be selected.

- [ ] Conceptual stage. Initial design
- [ ] Design optimization
- [ ] Construction
- [ ] Regulation
- [ ] Last stages of the design to verify and validate results

30. Do you think that BPSTs speed up the design stage?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

31. Do you think that simulation software can help you create the geometry of your architectural work?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

32. In which of the following fields do you think BPSTs can be useful?

More than one answer may be selected.

- [ ] Heating and cooling
- [ ] Air quality and ventilation
- [ ] Thermal comfort
- [ ] Acoustics
- [ ] Daylight and artificial lighting
- [ ] Fire safety
- [ ] All of them
- [ ] No answer

33. Do you think building simulation is essential before its construction?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Possibly

34. What do you think should be the economic cost of BPSTs?

Mark one only answer.

- ◯ Free
- ◯ Higher than the one of Autocad
- ◯ Lower than the one of Autocad
- ◯ Very high
- ◯ High but with discounts for students
- ◯ No answer

35. Among the following categories, identify which one best corresponds to the architectural design process followed by you:

More than one answer may be selected.

- ☐ Intuitive decisions taken using generalities
- ☐ Architect's experience
- ☐ Collaboration with other professionals within multidisciplinary groups
- ☐ Interaction between future users of the building
- ☐ Design through computer simulations
- ☐ Other

36. Building design depends on architect’s ability and experience

Mark one only answer.

- ◯ Fully agreed
- ◯ Agreed
- ◯ Disagreed
- ◯ No answer

37. Building design can be substituted by quantitative simulation software:

Mark one only answer.

- ◯ Fully agreed
- ◯ Agreed
- ◯ Disagreed
- ◯ No answer

38. Which of the following tools do you use in order to provide an optimum building design?

More than one answer may be selected.

- ☐ Own experience
- ☐ Design guidelines, generalities
- ☐ Energy certifications
- ☐ Lider-Calener
- ☐ External consultancy (proffesionals)
- ☐ Computer simulations
- ☐ Interactions with the owner
- ☐ Collaboration with other architects
- ☐ Other

39. BPSTs enable architects to reconsider several aspects previously ignored during the design process:

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

40. The energy aspects related to efficiency are a barrier for architects while creating adequate constructions in order to develop a functional building

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

41. An optimum-shape design is effective to avoid the use of blinds, awnings, doubled-glasses and modifications altering the shape design of the building

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

42. Do you think that BPSTs data export is NOT adapted to the architectural design necessities?

Mark one only answer.

	1	2	3	4	5	
Little						Much

43. Are improved tools necessary in order to integrate the energy assessment within the design?

Mark one only answer.

- Yes, we do need improved tools for the architectural integration
- Yes, we do need improved tools for the initial dimensioning of energy systems
- Yes, we do need improved tools in order to provide energy data
- Yes, we do need tools providing data for the construction process
- No, I consider that existent tools are successful
- None of the above

44. BPSTs raise confidence for taking architectural decisions

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

45. BPSTs lack of knowledge is what makes stakeholder not to trust in them

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

46. Do you think that the data obtained through simulation software are correct?

Mark one only answer.

- Yes
- No
- Possibly
- No answer

47. In order to obtain confidence, It is important to collaborate with experts in simulation software

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

48. Professionals using BPSTs have an absolute control on its parameters

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

49. Are you interested in the use of BPSTs in the future?

Mark one only answer.

- Yes
- No
- Possibly

50. It is possible to incorporate every decision made by an energy consultant in the design without damaging it

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

51. Incorporating numerical data to the design must be learnt

Mark one only answer.

- Fully agreed
- Agreed
- Disagreed
- No answer

52. Do you think that BPSTs are intended for professionals who are not architects?

Mark one only answer.

- Yes
- No
- Possibly

53. Do you think that BPSTs are intended for nearly zero energy buildings design?

Mark one only answer.

- Yes
- No
- Possibly

54. Do you think that BPSTs limit the architect's creativity during the design stage?

Mark one only answer.

- Yes
- No
- Possibly

55. Energy simulation interests you

Mark one only answer.

	1	2	3	4	5	
Little						Much

56. How BPSTs can be implemented in architecture offices?

More than one answer may be selected.

- [ ] Training students
- [ ] Hiring an expert
- [ ] Being mandatory to meet the regulation
- [ ] Being essential in architecture offices

57. Do you think that guides are necessary in order to show equivalences between the results obtained from BPSTs and passive strategies designed by architects?

Mark one only answer.

	1	2	3	4	5	
Little	◯	◯	◯	◯	◯	Much

58. Do you think that the identification of both architects' specific necessities and software advantages and disadvantages are essential in order to facilitate the use of BPSTs ? *Mark one only answer.*

- ◯ Yes
- ◯ No
- ◯ Possibly

59. Please, give your opinion or provide suggestions about the relationship between architects and simulation software.

Please, press NEXT if you have used BPSTs in order to continue with the survey. If you have not used BPSTs, please scroll down and press SEND

Thank you very much

Energy simulation software

Just for respondents who have used these type of software 15 questions. Estimated time: 5 minutes.

60. Have you taken specific training?

Mark one only answer.

- ◯ Yes
- ◯ No
- ◯ Self-taught

60.a) Where?

_____

_____

_____

_____

_____

60. b) If you have been self-taught, describe the quality of the software manuals used?

Mark one only answer.

- ◯ Very good
- ◯ Good
- ◯ Normal
- ◯ Bad
- ◯ Very bad

61. How often do you use simulation softwares?

Mark one only answer.

- ◯ Often
- ◯ Occasionally
- ◯ In Architecture competitions
- ◯ Never
- ◯ Other

62. How many years have you been using BPSTs?

Mark one only answer.

- ◯ Less than 1 year
- ◯ 1-2 years
- ◯ 2-3 years
- ◯ 3-5 years
- ◯ 5-20 years

63. Describe your level of satisfaction with the use of BPSTs

Mark one only answer.

	1	2	3	4	5	
Little	◯	◯	◯	◯	◯	Much

64. Do you think that the use of BPSTs is important in Architecture?

Mark one only answer.

- ◯ Important
- ◯ Normal
- ◯ Not important

65. Do you think that the use BPSTs is important in your field as an architect?

Mark one only answer.

- Important
- Normal
- Not important

66. How often do you use BPSTs to develop your projects?

Mark one only answer.

- Always
- Often
- Some times
- Ocasionally
- Never

67. Do you know any simulation tool which can be adequate for architects?

Mark one only answer.

- Yes
- No

67.a) Which one?

_____

68. To what extent the following parameters influence the selection of a BPST software? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Simple interface design					
Data export with other software(Autocad, Sketchup…)					
Cost					
Simulation time					
3D modelling included in the same software					
Easy data entry					
Position in the market					
Adaptation to the national regulation					
Easy interpretation of the results					
Auxiliary use of additional software					
Easy training					

69. Which of the next actions do you think is more important?

More than one answer may be selected.

- [ ] Explanation of the data input in the software
- [ ] Easy validation of the energy simulation (compared to real cases)
- [ ] Simplification of the options of the software to provide an easier interpretation of the results
- [ ] Detailed explanation of energy simulation software and its advantages for the architectonic design
- [ ] None

70. To what extent the following criteria are important considering the use and interface? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Easy output interpretation	◯	◯	◯	◯	◯
Flexible use	◯	◯	◯	◯	◯
Graphical representation of the results	◯	◯	◯	◯	◯
Adaptation to the national regulation	◯	◯	◯	◯	◯
Easy training	◯	◯	◯	◯	◯

71. To what extent do you think the following characteristics suppose a barrier for the BPSTs use? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Software evolution	◯	◯	◯	◯	◯
Complexity of use	◯	◯	◯	◯	◯
Learning curve	◯	◯	◯	◯	◯
Software tools not integrated in CAD tools	◯	◯	◯	◯	◯
High economic cost	◯	◯	◯	◯	◯
Poor interface	◯	◯	◯	◯	◯
Interpretation of outcomes	◯	◯	◯	◯	◯
Simple tools which do not provide the necessary information	◯	◯	◯	◯	◯

72. To what extent do you think the following characteristics about the use of BPSTs are important? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Data input and output, navigation and control					
Learning curve					
Documentation, online help					
Software tools not integrated in CAD tools					
Tables for consulting					
Use default values and data input templates					
Database where construction materials are easily found Base					
Graphic representation of the design parameters (easy to understand by architects) 3D					
Visualization and design strategies					
Templates for the user relating to HVAC					
Error checking in order to ensure that the models used are correct					
GLOBAL ASSESSMENT CRITERION					

73. To what extent do you think the following characteristics about knowledge are important? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Qualitative and quantitative knowledge about the design decisions					
Templated creation					
Meeting the codes and rating systems					
Find objective responses to design question.					
Life-cycle assessments					
Economic aspects					
Definition of the most important parameters in the design stage					
Approach based on comparative design					
Generation of design alternatives					
Materials selection during the design stage					
Decision making process					
Low cost buildings					
Orientation about passive design					
Big components library (façades, roofs, etc...)					
GLOBAL ASSESSMENT CRITERION					

74. To what extent do you think the following characteristics about ABILITIES are important? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Validity, quality and resolution					
Accuracy					
Ability to simulate elements with sufficient detail					
Optimization of the building envelope					
Consideration of natural ventilation					
Information of the cost of energy reduction measures					
GLOBAL ASSESSMENT CRITERION					

75. To what extent do you think the following characteristics about INTEROPERABILITY are important? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
It transfers information from one software to another without losing information and in a comfortable way					
It enables to manage and communicate construction data between different collaborators					
It alllows modeling of organic volumen and non-cubic zones					
It allows the input of multiple modeling programs					
GLOBAL ASSESSMENT CRITERION					

76. To what extent do you think the following characteristics about DESIGN are important? 1(Little) 5(Much)

Mark one only answer.

	1	2	3	4	5
Alternation of the simulation process with the design process					
Multidisciplinary interfaces					
GLOBAL ASSESSMENT CRITERION					

77. Please, write your opinion or suggestion

78. Please, write your general opinion about this survey

THANK YOU VERY MUCH. Please, do not forget to press SEND