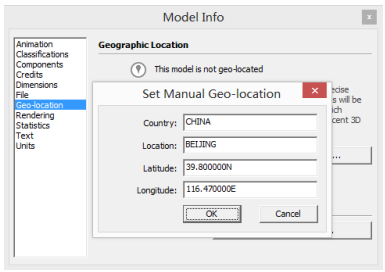
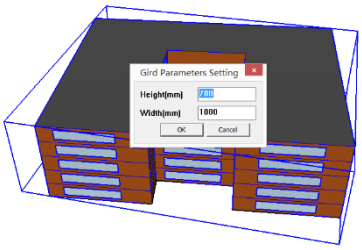
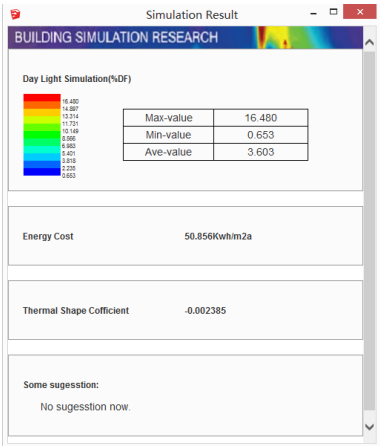
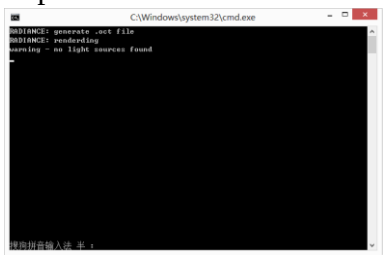
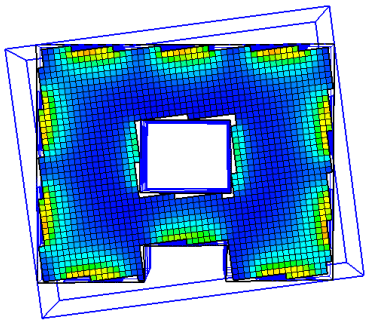
Table 4. *One-key simulation procedure*

Step1: Set latitude and longitude 	Step2: Set grid height 	Step5: Simulation result 
Step3: Call Radiance/Messg/Tsc interface to perform simulation 	Step4: Daylight simulation results rendering 	

(4) Thermal performance analysis of building envelope

The self-developed solar analysis tool was able to calculate shadow proportion of building surface, but couldn't calculate radiation heat gain received by building surface, so it couldn't deal with schemes with self-occlusion. The following cases were calculated manually.

4 cases with almost the same building area were designed in this research. Case 1 was the reference design scheme. Heat transfer coefficient of exterior wall was 0.6 W/(m^2 K), heat transfer coefficient of roof was 0.55 W/(m^2 K). WWR of north façade was 0.3, heat transfer coefficient of window was 3.5 W/(m^2 K), SHGC was 0.7; WWR of building facades towards other orientations was 0.7, heat transfer coefficient was 2.0 W/(m^2 K), SHGC was 0.5.

Table 5. *Cases for TSC calculation*

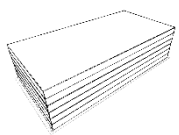
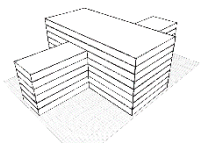
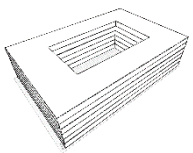
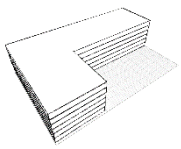
Case 1	Case 2	Case 3	Case 4
			

Table 6. *TSC values*

	Case 1	Case 2	Case 3	Case 4

Building area (m^2)	14700	14796	14688	14688
TSC (m^{-1})	8.42	10.79	12.89	9.57
Shape coefficient (m^{-1})	0.141	0.174	0.208	0.158

DISCUSSION

(1) Workflow: The plug-in's workflow, concise and normative, is able to more comply with architects' thinking mode and working style, easy to be combined with various performance analysis tools.

(2) Solar analysis tool: Verification of accuracy shows that, shadow proportion calculated by solar tool is higher than by Ecotect, and the relative deviation in winter is higher than that in summer. The solar tool isn't able to calculate solar radiation heat gain and sunshine hours received by building surface. If the tool's functions can be expanded and accuracy be improved, the TSC value and energy consumption can be calculated based on the radiation heat gain calculated by the solar tool, furthermore, shading forms can be optimized to improve diversity of design solutions.

(3) Daylighting analysis: Radiance interface was called to calculate interior daylight factor successfully.

(4) TSC calculation: In this research, TSC was introduced into the simulation-aided-design process. Schemes were compared and selected through comparing TSC values, furthermore, the TSC values could be used to optimize parameters of building envelope.

CONCLUSION AND IMPLICATIONS

Taking architects' thinking mode and working style into consideration, with the objective of improving building performance, in light of uncertainty of construction details in early design stage, a fast simulation-aided-design plug-in integrated into Sketchup for office building was developed in this research. Aiming at the research objective, modeling procedure was established, the solar analysis tool which was able to calculate shadow proportion of building surface was developed, Radiance interface was successfully called to perform daylighting simulation, and probability of TSC calculation method was verified in this research. Further work includes, optimize modeling procedure, finish development and calling of all the performance analysis tools, strengthen the correlation between various performance analysis method and tools, improve the computation speed, accuracy and improve the plug-in's robustness.

REFERENCES

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